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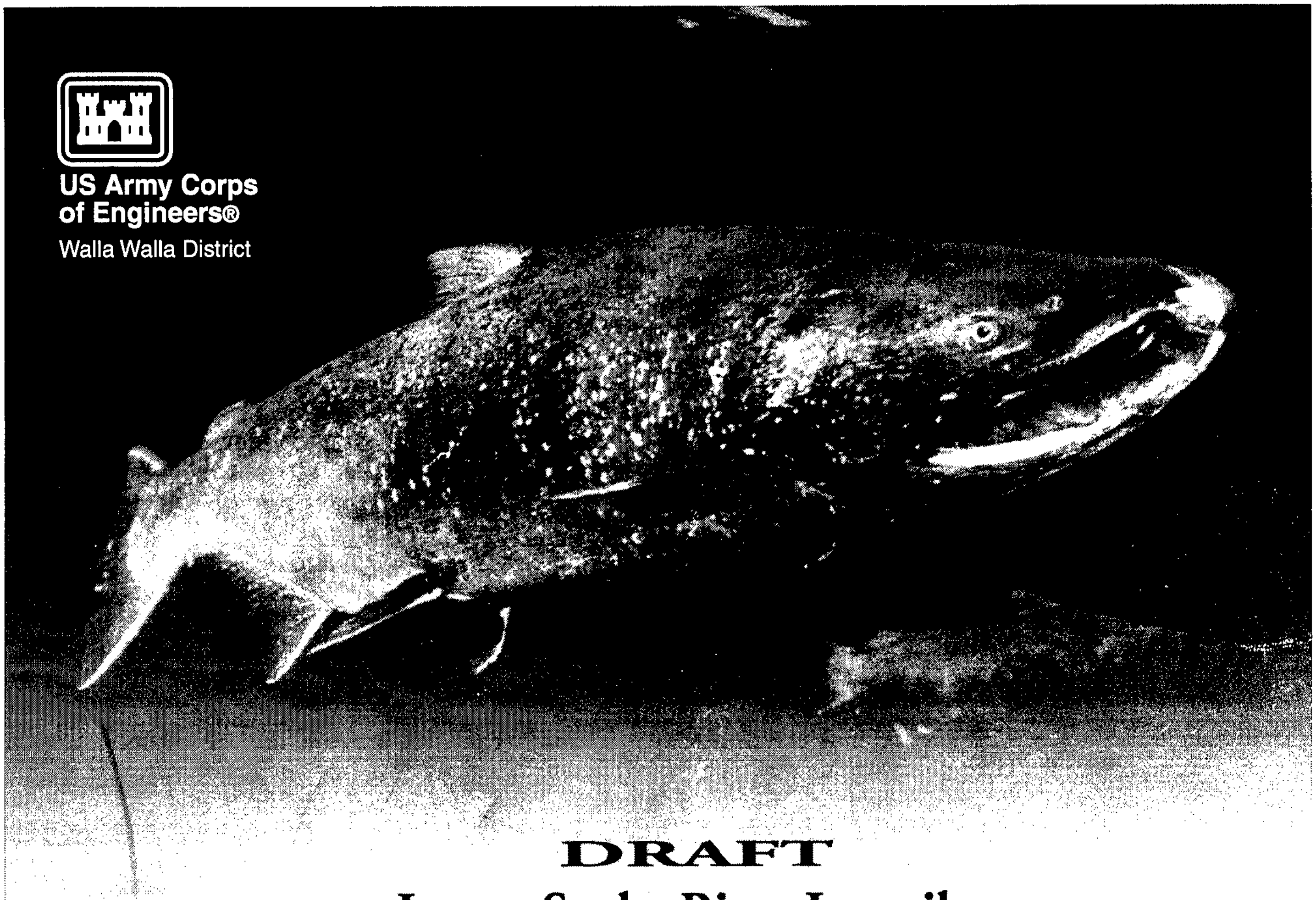

DRAFT
Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement

APPENDIX I
Economics

December 1999

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The Corps of Engineers along with the Bonneville Power Administration, US Environmental Protection Agency, and US Bureau of Reclamation as cooperating agencies, analyzed four general alternatives intended to provide information on the technical, environmental, and economic effects of actions related to improving juvenile salmon passage. The four alternatives include Alternative 1 - Existing Conditions (the no-action alternative) and three different ways to further improve juvenile salmon passage. The action alternatives are: Alternative 2 - Maximum Transport of Juvenile Salmon, Alternative 3 - Major System Improvements, and Alternative 4 - Dam Breaching. Comparison of the alternatives by all of the factors assessed in the study has not offered a clear-cut recommendation at this time. It is the Corps of Engineer's intent to recommend a preferred plan of action in the Final FR/EIS.

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Summary to the Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement	
Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement	
Appendix A	Anadromous Fish
Appendix B	Resident Fish
Appendix C	Water Quality
Appendix D	Natural River Drawdown Engineering
Appendix E	Existing Systems and Major System Improvements Engineering
Appendix F	Hydrology/Hydraulics and Sedimentation
Appendix G	Hydroregulations
Appendix H	Fluvial Geomorphology
Appendix I	Economics
Appendix J	Plan Formulation and Decision Analysis Model
Appendix K	Real Estate
Appendix L	Lower Snake River Mitigation History and Status
Appendix M	Fish and Wildlife Coordination Act Report
Appendix N	Cultural Resources
Appendix O	Public Outreach Program
Appendix P	Air Quality
Appendix Q	Tribal Consultation/Coordination
Appendix R	Historical Perspectives
Appendix S	Snake River Maps
Appendix T	Biological Assessment
Appendix U	Clean Water Act, Section 404(b)(1) Evaluation

The documents listed above, as well as supporting technical reports and other study information, are available on our website at www.nww.usace.army.mil. Copies of these documents are also available for public review at various city, county, and regional libraries.

FOREWORD

This appendix is one part of the overall effort of the U.S. Army Corps of Engineers' (Corps) to prepare a Lower Snake River Juvenile Salmon Migration Feasibility Report/Environmental Impact Statement (FR/EIS).

Please note that this document is a DRAFT appendix and is subject to change and/or revision based on information received through comments, hearings, workshops, etc. After the comment period ends and hearings are concluded, a Final FR/EIS with Appendices is planned.

The Corps has reached out to other regional stakeholders (Federal agencies, tribes, states, local governmental entities, organizations, and individuals) during the development of the FR/EIS and appendices. This effort resulted in many of these regional stakeholders providing input, comments and even drafting work products or portions of these documents. This regional input provided the Corps with an insight and perspective not found in previous processes. An example of regional stakeholders drafting and authoring products can be found in this appendix.

This reach out effort resulted in the formation of the Drawdown Regional Economic Workgroup. The DREW study teams prepared numerous and detailed economic and social analyses, i.e. DREW Workgroup products. These products are the core technical information for this appendix. Some of these work products are still considered a work in progress and this appendix incorporates information from the latest versions available. Citations to these products can be found throughout this appendix and FR/EIS and can be found in full text on the Corps web page. A great deal of the information was subsequently included in the Draft FR/EIS and Appendices, therefore, not all the opinions and/or findings herein may reflect the official policy or position of the Corps.

STUDY OVERVIEW

Purpose and Need

Between 1991 and 1997, due to declines in abundance, the National Marine Fisheries Service (NMFS) made the following listings of Snake River salmon or steelhead under the Endangered Species Act (ESA) as amended:

- sockeye salmon (listed as endangered in 1991)
- spring/summer chinook salmon (listed as threatened in 1992)
- fall chinook salmon (listed as threatened in 1992)
- steelhead (listed as threatened in 1997)

In 1995, NMFS issued a Biological Opinion on operations of the Federal Columbia River Power System. The Biological Opinion established measures to halt and reverse the declines of these listed species. This created the need to evaluate the feasibility, design, and engineering work for these measures.

The U.S. Army Corps of Engineers (Corps) implemented a study after NMFS's Biological Opinion in 1995 of alternatives associated with lower Snake River dams and reservoirs. This study was named the Lower Snake River Juvenile Salmon Migration Feasibility Study (Feasibility Study). The specific purpose and need of the Feasibility Study is to evaluate and screen structural alternatives that may increase survival of juvenile anadromous fish through the Lower Snake River Project (which includes the four lowermost dams operated by the Corps on the Snake River—Ice Harbor, Lower Monumental, Little Goose, and Lower Granite dams) and assist in their recovery.

Development of Alternatives

The Corps completed an interim report on the Feasibility Study in December 1996. The report evaluated the feasibility of drawdown to natural river levels, spillway crest, and other improvements to existing fish passage facilities. Based in part on a screening of actions conducted in the interim report, the study now focuses on four courses of action:

- Existing conditions (currently planned fish programs)
- System improvements with maximum collection and transport of juveniles (without major system improvements such as surface bypass collectors)
- System improvements with maximum collection and transport of juveniles (with major system improvements such as surface bypass collectors)
- Dam breaching or permanent drawdown to natural river levels for all reservoirs

The results of these evaluations are presented in the combined Feasibility Report (FR) and Environmental Impact Statement (EIS). The FR/EIS provides the support for recommendations that will be made regarding decisions on future actions on the Lower Snake River Project for passage of juvenile salmonids. This appendix is a part of the FR/EIS.

Geographic Scope

The geographic area covered by the FR/EIS generally encompasses the 140-mile long lower Snake River reach between Lewiston, Idaho and the Tri-Cities in Washington. The study area does slightly vary by resource area in the FR/EIS because the affected resources have widely varying spatial characteristics throughout the lower Snake River system. For example, socioeconomic effects of a permanent drawdown could be felt throughout the whole Columbia River Basin region with the most effects taking place in the counties of southwest Washington. In contrast, effects on vegetation along the reservoirs would be confined to much smaller areas.

Identification of Alternatives

Since 1995, numerous alternatives have been identified and evaluated. Over time, the alternatives have been assigned numbers and letters that serve as unique identifiers. However, different study groups have sometimes used slightly different numbering or lettering schemes and this has lead to some confusion when viewing all the work products prepared during this long period. The primary alternatives that are carried forward in the FR/EIS currently involve four major alternatives that were derived out of three major pathways. The four alternatives are:

Alternative Name	PATH[1/] Number	Corps Number	FR/EIS Number
Existing Conditions	A-1	A-1	1
Maximum Transport of Juvenile Salmon	A-2	A-2a	2
Major System Improvements	A-2'	A-2c	3
Dam Breaching	A-3	A-3a	4

[1/] Plan for Analyzing and Testing Hypotheses

Summary of Alternatives

The **Existing Conditions Alternative** consists of continuing the fish passage facilities and project operations that were in place or under development at the time this Feasibility Study was initiated. The existing programs and plans underway would continue. Project operations, including all ancillary facilities such as fish hatcheries and Habitat Management Units (HMUs) under the Lower Snake River Fish and Wildlife Compensation Plan (Comp Plan), recreation facilities, power generation, navigation, and irrigation would remain the same unless modified through future actions. Adult and juvenile fish passage facilities would continue to operate.

The **Maximum Transport of Juvenile Salmon Alternative** would include all of the existing or planned structural and operational configurations from the Existing Conditions Alternative. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport from Lower Granite, Little Goose, and Lower Monumental and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor). To accommodate this maximization of transport some measures would be taken to upgrade and improve fish handling facilities.

The **Major System Improvements Alternative** would provide additional improvements to what is considered under the Existing Conditions Alternative. These improvements would be focused on using surface bypass collection (SBC) facilities in conjunction with extended submersible bar screens (ESBS) and a behavioral guidance system (BGS). The intent of these facilities is to provide more effective diversion of juvenile fish away from the turbines. Under this alternative the number of fish collected and delivered to upgraded transportation facilities would be maximized at Lower Granite, the most upstream dam, where up to 90 percent of the fish would be collected and transported.

The **Dam Breaching Alternative** has been referred to as the "Drawdown Alternative" in many of the study groups since late 1996 and the resulting FR/EIS reports. These two terms essentially refer to the same set of actions. Because the term drawdown can refer to many types of drawdown, the term dam breaching was created to describe the action behind the alternative. The Dam Breaching Alternative would involve significant structural modifications at the four lower Snake River dams allowing the reservoirs to be drained and resulting in a free-flowing river that would remain unimpounded. Dam breaching would involve removing the earthen embankment sections of the four dams and then developing a channel around the powerhouses, spillways, and navigation locks. With dam breaching, the navigation locks would no longer be operational, and navigation for large commercial vessels would be eliminated. Some recreation facilities would close while others would be modified and new facilities could be built in the future. The operation and maintenance of fish hatcheries and Habitat Management Units (HMUs) would also change although the extent of change would probably be small and is not known at this time. Project development, design, and construction span a period of nine years. The first three to four years concentrate on the engineering and design processes. The embankments of the four dams are breached during two construction seasons at year 4-5 in the process. Construction work dealing with mitigation and restoration of various facilities adjacent to the reservoirs follows dam breaching for three to four years.

Authority

The four Corps dams of the lower Snake River were constructed and are operated and maintained under laws that may be grouped into three categories: 1) laws initially authorizing construction of the project, 2) laws specific to the project passed subsequent to construction, and 3) laws that generally apply to all Corps reservoirs.

BOUNDARIES

State

County

KM 300 100 0

MILES 7.5 15 30

125,000 ACRES

1 : 1,900,800

GEOGRAPHIC INFORMATION SYSTEMS
Corps of Engineers
Walla Walla District

DRAFT

Lower Snake River
Juvenile Salmon Migration Feasibility Study

REGIONAL BASE MAP

1999

GIS Analysis & Graphic Assembly: Applied Technology Team (CENWW-PM-PD-EJ)
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ABSTRACT

This is the Economics Appendix to the Lower Snake River Juvenile Salmon Migration Feasibility Study FR/EIS. This appendix was compiled by the U.S. Army Corps of Engineers from technical studies developed by the Drawdown Regional Economic Workgroup (DREW). Members of DREW include representatives of various Federal and regional agencies, tribal representatives, and other interested parties. This appendix measures the economic and social effects of the four proposed alternatives. Potential economic and social effects are addressed at three geographic scales — national, regional, and local. Local effects include those to Native American tribes and potentially affected communities.

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Lower Snake River Juvenile Salmon Migration Feasibility Report/ Environmental Impact Statement

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Appendix I

Economics

Produced by

Foster Wheeler Environmental Corporation

Produced for

U.S. Army Corps of Engineers

Walla Walla District

Completed December 1999
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with Draft FR/EIS
December 1999

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ACRONYMS AND ABBREVIATIONS

AAEV	average annual equivalent value
AECO	Alberta Energy Company
AEI	Agricultural Enterprises, Inc.
AFEP	anadromous fish evaluation program
AGC	Automatic Generation Control
aMW	average megawatt
BCAM	Barge Cost Analysis Model
BGS	behavioral guidance system
BLMR	Blue Mountain Railroad
BOR	Bureau of Reclamation
BPA	Bonneville Power Administration
CB	contingent behavior
CC	cycle combustion turbine
CCC	Civilian Conservation Corps
CEAA	Canadian Entitlement Allocation Agreement
CEQ	Council on Environmental Quality
COI/PDCI	California-Oregon Intertie/Pacific Direct Current Intertie
Corps	U.S. Army Corps of Engineers
CRITFC	Columbia River Inter Tribal Fisheries Commission
CSRS	Columbia Snake River System
CT	combustion turbine
CTUIR	Confederated Tribes of the Umatilla Indian Reservation
CVM	Contingent Valuation Method
DGAS2	second phase of de-gasification construction project
DREW	Drawdown Regional Economic Workgroup
EIS	Environmental Impact Statement
EJ	Environmental Justice
EPA	U.S. Environmental Protection Agency
EQ	environmental quality
ESA	Endangered Species Act
ESBS	extended submerged bar screen
FCRPS	Federal Columbia River Power System
FEAM	fisheries economic assessment model
FELCC	firm energy load carrying capacity
FERC	Federal Energy Regulatory Commission
FR/EIS	Feasibility Report/Environmental Impact Statement
FY	Fiscal Year
HIT	Hydropower Impact Team
HMU	Habitat Management Unit
HP	horsepower
HQUSACE	U.S. Army Corps of Engineers Headquarters
HYDROSIM	Hydro Simulation Program
HYSSR	Hydro System Seasonal Regulation Program

ACRONYMS AND ABBREVIATIONS

IDC	interest during construction
IEAB	Independent Economic Advisory Board
INPFC	International North Pacific Fisheries Commission
IWR	Institute for Water Resources
kV	kilovolt
kWh	kilowatt-hours
LPMS	Lock Performance Monitoring System
LSR	lower Snake River
LSRFWCP	Lower Snake River Fish and Wildlife Compensation Plan
M&I	municipal and industrial
MAF	million acre-feet
MMBtu	million British thermal unit
MOA	Memorandum of Agreement
MOP	minimum operating pool
MOU	Memorandum of Understanding
mph	miles per hour
MW	megawatt
MWh	megawatt-hours
NED	National Economic Development
NEPA	National Environmental Policy Act
NEV	net economic value
NMFS	National Marine Fisheries Service
NPPC	Northwest Power Planning Council
NRCS	Natural Resource Conservation Service
NRSA	nominal range sensitivity analysis
NWPPC	
O&M	operation and maintenance
ODFW	Oregon Department of Fish and Wildlife
O,M,R,R&R	operation, maintenance, repair, replacement and rehabilitation
OR/WA	Oregon/Washington
OSE	Other social effects
P&G	Principles and Guidelines for Water and Related Sand Resources
PATH	Plan for Analyzing and Testing Hypotheses
PFMC	Pacific Fishery Management Council
PNCA	Pacific Northwest Coordination Agreement
PNW	Pacific Northwest
PST	Pacific Salmon Treaty
PSW	Pacific Southwest
PUD	Public Utility District
PV	present value
RCAM	Rail Cost Analysis Model
RED	regional economic development
RM	River Mile

ACRONYMS AND ABBREVIATIONS

ROD	Record of Decision
SBC	surface bypass collector
SOR	System Operation Review
SRP	PATH Scientific Review Panel
TAM	transportation analysis model
TCAM	Travel Cost Analysis Model
TCM	Travel Cost Method
UI	University of Idaho
UNCLOS	United Nations Convention on the Law of the Sea
URCS	Uniform Rail Costing System
USFWS	U.S. Fish and Wildlife Service
WCSC	Waterborne Commerce Statistics
WPPSS	Washington Public Power Supply System
WRC	U.S. Water Resources Council
WSCC	Western Systems Coordinating Council
WTP	willingness to pay
WY	water year

Executive Summary

ES.1 Introduction

This appendix measures the economic and social effects of the alternatives proposed under the Lower Snake River Juvenile Salmon Migration Feasibility Study. Section 102 of the National Environmental Policy Act (NEPA) and the Council on Environmental Quality (CEQ) guidelines, which interpret NEPA, require that the economic and social effects be identified. Evaluation of these effects is critical to decision makers and also important to others interested in the outcome of this study. The evaluation presented in this document uses economic measures to evaluate efficiency changes in the nation's production of goods and services. This evaluation is designed to identify the gains and losses to society as a whole. The effects that the proposed alternatives would have upon the region and on specific groups of individuals are also examined.

Actions taken to improve fish passage and survival along the lower Snake River could have economic and social effects on local communities, the Snake River region, the Pacific Northwest, and the nation, as a whole. The economic effects of actions related to the lower Snake River have been analyzed by numerous entities throughout the region. To reduce conflicting analyses and pool resources for a more efficient effort, the Corps convened the Drawdown Regional Economic Workgroup (DREW) to develop a combined economic analysis. Members of DREW include representatives of various Federal and regional agencies, tribal representatives, and other interested parties.

ES.1.1 Structure of Analysis

DREW conducted the necessary technical analyses to assess the potential economic and social effects of the four alternatives. These analyses address potential economic and social effects at three geographic scales — national, regional, and local. The overall structure of the economic and social analysis developed for the Lower Snake River Juvenile Salmon Migration Feasibility Study is based on the Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies developed by the U.S. Water Resources Council (WRC) (WRC, 1983). These guidelines recommend that the evaluation and display of the effects of proposed alternatives be organized into four accounts:

- The national economic development (NED) account, which displays changes in the economic value of the national output of goods and services
- The environmental quality (EQ) account, which displays nonmonetary effects on significant natural and cultural resources
- The regional economic development (RED) account, which addresses changes in the distribution of regional economic activity
- The other social effects (OSE) account, which addresses potential effects from relevant perspectives that are not reflected in the other three accounts

The NED account is the only account required under the WRC guidelines. The guidelines recommend that other information that is required by law or that will have a material bearing on the decision-making process should be included in one of the other accounts (EQ, RED, or OSE) or in some other appropriate format. The four accounts and their relationship to this analysis are discussed in the following sections.

ES.1.1.1 National Economic Development (NED)

The NED account addresses the net effects of a proposed action upon the nation. NED analysis is concerned only with economic efficiency at the national level. Economic gains achieved by one region at the expense of another region are not measured as NED benefits. In most cases, this type of gain to one region is another region's loss, and the two effects represent a transfer of income that cancels out any net change. Regional impacts are addressed under the RED account.

Beneficial effects measured under the NED account include increases in the economic value of the national output of goods and services, the value of output resulting from external economies caused by the proposed alternative, and the value associated with the use of otherwise unemployed or under-employed labor resources. Adverse NED effects are usually the opportunity costs of resources used in implementing a plan. All resources are scarce, and we are forced to make choices when they are used. Choose more of one thing, and you are simultaneously choosing less of another.

The general measurement standard for the value of goods and services is defined as the willingness of users to pay for each increment of output associated with a proposed alternative. Since it is not usually possible to obtain actual willingness to pay values, alternative or proxy measures are used. These measures include actual or simulated market price, change in net income, cost of the most likely alternative, and administratively established values.

ES.1.1.2 Environmental Quality Account

The EQ account provides a means of displaying and integrating qualitative information on the effects of the proposed alternatives on significant resources and attributes of the human environment. Beneficial and adverse effects addressed in the EQ account include changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources. The evaluation of tribal circumstances presented in this appendix may be considered part of this account.

ES.1.1.3 Regional Economic Development (RED)

The RED account addresses changes in regional economic activity that result from each alternative plan. Effects are addressed in terms of changes to regional business sales, employment, and income. The majority of effects associated with the proposed alternatives would occur in the lower Snake River region. Effects were modeled for the lower Snake River region and three subregions. Impacts, such as increased power rates, that could affect the entire Pacific Northwest were modeled at the state level.

ES.1.1.4 Other Social Effects (OSE)

The OSE account addresses potential effects from perspectives that are relevant to the evaluation process, but are not reflected in the other three accounts. Categories typically addressed as part of this account include community impacts; life, health, and safety factors; displacement; and long-

term productivity. The social analysis developed as part of this study addresses some of the likely social impacts on selected local communities.

ES.1.2 Study Assumptions

A 100-year period of analysis was used to assess all project impacts. The base year for the analysis was fiscal year (FY) 1998, but the 100-year period of analysis extends from the implementation year (FY 2005) through 2104. Benefits and costs incurred during the period of analysis are discounted to the beginning of this period (FY 2005) using selected interest rates. Implementation expenditures and other economic costs and benefits that would occur prior to FY 2005 are brought forward to that date by charging compound interest at the project discount rate from the date that the costs and benefits occur. These costs and benefits are then converted into 1998 dollars and annualized to provide an average annual value for each alternative.

Numerous agencies and interests were involved in developing this economic analysis. As a result, effects are presented using three different discount rates: 6.875 percent — the rate used in economic analyses by the Corps, 4.75 percent — the rate customarily used by BPA, and 0 percent — included on behalf of the tribes represented by CRITFC. While these different discount rates have been used to accommodate a variety of perspectives, the use of these rates had little effect on the ranking of the alternatives.

ES.1.3 Alternatives

The Lower Snake River Juvenile Salmon Migration Feasibility Study FR/EIS examines four alternatives. These alternatives are as follows:

Alternative 1, Existing Conditions. This alternative continues the fish passage facilities and project operations that were in place or under development at the time this Feasibility Study was initiated.

Alternative 2, Maximum Transport of Juvenile Salmon. This alternative includes all of the existing or planned structural and operational configurations from the Existing Conditions Alternative. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport from Lower Granite, Little Goose, and Lower Monumental and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor).

Alternative 3, Major System Improvements. This alternative provides additional improvements to those considered under the Existing Conditions Alternative. These improvements would be focused on using surface bypass collection (SBC) facilities in conjunction with extended submersible bar screens (ESBS) and a behavioral guidance system (BGS). The intent of these facilities is to provide more effective diversion of juvenile fish away from the turbines.

Alternative 4, Dam Breaching. This alternative involves significant structural modifications at the four lower Snake River dams, allowing the reservoirs to be drained and resulting in a free-flowing river that would remain unimpounded. Dam breaching would involve removing the earthen embankment sections of the four dams and then developing a channel around the powerhouses, spillways, and navigation locks. With dam breaching, the navigation locks would no longer be operational, and navigation for large commercial vessels would be eliminated. Some recreation facilities would close, while others would be modified, and new facilities could be built in the future.

ES.1.4 Biological Benefits

There are four species of fish in the lower Snake River system that have been listed as endangered by the National Marine Fisheries Service (NMFS) under the Endangered Species Act. These are spring/summer chinook, fall chinook, steelhead and sockeye. The effects of the proposed alternatives in improving the chances of recovery and survival of these species are considered the "benefits" or "output" of undertaking the study alternatives. This section briefly discusses the Plan for Analyzing and Testing Hypotheses (PATH) results and the development and application of the NMFS jeopardy standards.

PATH is a formal and rigorous program of formulating and testing hypotheses by using a series of model simulations to estimate both past and future trends in fish abundance for each of the selected stocks. The primary objective of PATH's modeling is to enhance the survival opportunities of the affected Evolutionary Significant Units (ESUs) by considering the stock's response to jeopardy standards, which were defined by the Biological Requirements Working Group (BRWG) and largely accepted by NMFS. (Source: **PATH Decision Analysis Report for Snake River Fall Chinook**, September 1999, Appendix I).

The jeopardy standards include both survival and recovery goals as defined below:

- Survival standards (which set the threshold for survival) are based on projected probabilities that the spawning abundance will exceed a pre-defined survival threshold over a 24 or 100 year simulation period. Survival standards are met when that probability is 70% or greater.
- Recovery standards (which are required to consider de-listing of the species) are based on probabilities of exceeding a recovery threshold in the last eight years of a 48-year simulation period. This standard is met when the probability is 50% or greater".

Table ES-1 presents a comparison of alternative results based upon data provided by NMFS and PATH using 1998 model results. None of the alternatives meets all of the jeopardy standards using 1998 PATH model results. Alternative 4, Dam Breaching, comes the closest to meeting all of the jeopardy standards for both spring/summer and fall chinook (i.e., this alternative meets five out of six standards). The other three alternatives come relatively close to meeting all of the jeopardy standards, with the exception of the 48-year recovery standard for fall chinook.

However, PATH is continuing to refine the model, using new information on key variables related to delayed mortality (the D factor), ocean conditions, and ocean harvests, among other variables. These modifications are having an effect on model results for fall chinook. According to the Peters et al., 1999 (September 1999):

- **All hydrosystem actions meet survival standards** (probabilities of exceeding survival escapement thresholds are greater than 0.7), regardless of what is assumed about the estuary/ocean survival rate of transported fish.
- **All drawdown actions meet recovery standards** (probabilities of exceeding recovery escapement thresholds are greater than 0.5) regardless of what is assumed about the estuary/ocean survival rate of transported fish. The drawdown action (A3 [named Alternative 4 in this FR/EIS]) exhibited the most robust response across those uncertainties considered to date, and produced

higher recovery probabilities (as well as higher average spawning escapements) than other actions. This conclusion is sensitive to assumptions about adult upstream survival.

- For each hypothesis about relative survival of transported fish, **there is a non-breaching action (actions which do not involve drawdowns of dams) that meets the recovery standard,** although there is no single non-breaching alternative option that meets recovery standards under all assumptions about the relative survival of transported fish. If transported fish are assumed to have high relative survival (i.e., high D), maximizing transportation will achieve recovery standards. If transported fish are assumed to have low relative survival (i.e., low D), then retaining current system configuration and allowing all smolts to migrate in-river achieves the recovery standards. **Non-breaching actions are not as robust to the current level of uncertainty in relative survival of transported fish as are drawdown actions.** (Page 8)

The 1999 PATH model results are not available in the same format as the 1998 model results reported in Table ES-1.

Table ES-1. Ability to meet the NMFS Jeopardy standards for survival and recovery based upon 1998 PATH model results (median values presented)

Biological Benefits	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Spring/Summer Chinook				
Survival in 24th year (standard is 0.70)	0.67	0.65	0.66	0.69
Recovery in 48th Year (standard is 0.50)	0.48	0.45	0.46	0.84
Survival in 100th year (standard is 0.70)	0.79	0.78	0.79	0.89
Fall Chinook				
Survival in 24th year (standard is 0.70)	0.85	0.85	0.81	0.93
Recovery in 48th Year (standard is 0.50)	0.22	0.22	0.28	1.00
Survival in 100th Year (standard is 0.50)	0.83	0.83	0.78	0.98

Source: NMFS, PATH

ES.2 National Economic Development

National Economic Development (NED) costs and benefits are the decrease or increase in the value of the national output of goods and services expressed in dollars. NED figures reflect costs and benefits to the nation and not to a particular region. The NED analysis conducted for this study addresses power, recreation, transportation, water supply, commercial fishing, tribal circumstances, flood control, and implementation/avoided costs. These resource areas are addressed in turn in the following sections.

ES.2.1 Power

The four lower Snake River dams are part of an integrated system of hydroelectric facilities located throughout the Columbia River Basin. This system provides a number of products and services, including firm and non-firm energy; peak, and sustained capacity; daily load-following capacity; and other attributes that contribute to the reliability of the regional power system. Changing system hydropower operations affects the ability of the regional power system to generate electricity and the cost of generating that electricity. Changing hydropower operations also affects system reliability and capability, transmission, and ancillary services.

Changes in the regional power system's ability to provide energy and capacity, and the cost of providing these products, form the core of the power system impact analysis conducted by the DREW Hydropower Impact Team. The overall goal of the DREW Hydropower Impact Team study was to develop an estimate of the net economic effects associated with the changes in hydropower under each of the alternatives. This involved a number of steps. The first step involved using system hydro-regulation studies to estimate how much hydropower generation would occur under the different alternatives and under different water conditions. This information was then incorporated into three different power system models to estimate how changes in hydropower generation would affect generation from other more costly power resources. The effects of these hydropower changes on the market price of electricity over time were also estimated.

The range of net economic effects that was estimated based on the different power system models and different assumptions of future conditions is shown for the three project discount rates in Table ES-2. The point estimates used in the NED analysis are the midpoints between the minimum and maximum values.

Alternative 1, Existing Conditions, is considered the base condition for this analysis. The results of the analysis for the other alternatives are compared with this condition. The DREW Hydropower Impact Team analysis evaluated Alternative 2, Maximum Transport of Juvenile Salmon, and Alternative 3, Major System Improvements, as one cumulative alternative. The minor differences in generation that might occur between the two alternatives were not addressed in the DREW Hydropower Impact Team analysis. This combined alternative would result in increases in system hydropower generation. It is not expected that the transmission system would be impacted with this alternative, and the changes in ancillary services are considered to be minimal. The point estimate of average annual net economic benefits is $9 million.

Under Alternative 4, Dam Breaching, the four hydropower facilities would no longer be operated, natural river levels would exist, and no hydropower generation would occur at the four lower Snake River dams. The analysis of this alternative did not include any hydropower impacts that may occur with changes in irrigation withdrawal from the lower Snake River reservoirs. The point estimate of average annual net economic costs consists of three components: 1) the point estimate of system costs is $238 million, 2) the point estimate of transmission reliability costs is $25 million, and 3) the estimate of ancillary service costs is $8 million. This results in annual total net economic costs of $271 million.

Table ES-2. Power - Average Annual Net Economic Effects by Discount Rate (1998 Dollars) ($1,000s)

	6.875 % Discount Rate		4.75 % Discount Rate		0.0 % Discount Rate	
Benefits/Costs	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
Alternatives 2 and 3						
System	10,000	7,000	10,000	7,000	9,000	7,000
Transmission Reliability	0	0	0	0	0	0
Ancillary Services	0	0	0	0	0	0
Total	**10,000**	**7,000**	**10,000**	**7,000**	**9,000**	**7,000**
Total Point Estimate		**8,500**		**8,500**		**8,000**
Alternative 4						
System	(221,000)	(255,000)	(220,000)	(256,000)	(217,000)	(260,000)
Transmission Reliability	(22,000)	(28,000)	(19,000)	(24,000)	(16,000)	(18,000)
Ancillary Services	(8,000)	(8,000)	(8,000)	(8,000)	(8,000)	(8,000)
Total	**(251,000)**	**(291,000)**	**(247,000)**	**(288,000)**	**(241,000)**	**(286,000)**
Total Point Estimate		**(271,000)**		**(267,500)**		**(263,500)**

ES.2.2 Recreation and Tourism

A measure of the direct economic value of goods and services, including recreation activity, is the willingness-to-pay (WTP) of users. For goods that are sold in a market, the WTP is the amount actually paid to obtain the good, plus an additional amount that an individual would have been willing to pay over and above the amount actually paid. In the case of valuing recreation, the amount charged for the activity is generally small or non-existent. Since there is no well-established market for the exchange of recreation goods, non-market approaches need to be employed to develop demand curves to estimate consumer surplus. The recreation and tourism analysis conducted by the DREW Recreation Workgroup employed the Travel Cost Method (TCM) to calculate net WTP for existing recreation activities and a hybrid TCM approach known as "contingent behavior" to estimate the value of river recreation under Alternative 4, Dam Breaching.

Five recreation-use surveys were conducted as part of this study by the DREW Recreation Workgroup. Four of these surveys were designed to identify and value current recreation use. Based on these surveys, existing reservoir use and annual benefits involved 500,172 trips worth $33,254,000 a year. Total existing recreation use identified through these surveys involved 640,685 trips worth $38,524,000 a year (Table ES-3).

The DREW Recreation Workgroup also surveyed a much larger sample of Washington, Idaho, Oregon, western Montana, and California residents to identify the type and number of recreation users who would visit the lower Snake River if the dams were breached. The survey described the new recreation conditions and asked whether the respondent would visit and, if so, how many times a year. Respondents were also asked the distance, travel cost, and travel time to the spot on the river

Table ES-3. Existing Recreation Surveys, Number of Trips, and Annual Benefits (1998 Dollars)

Survey	Number of Completed Surveys	Response Rate (%)	Number of Trips	Willingness to Pay per Trip ($)	Annual Benefits (000s of dollars)
Reservoir Angler	537	59	57,388	29.23	1,676
Reservoir General Recreation (excludes Angling)	408	65	442,834	71.31	31,578
Upriver Angler	247	72	11,437	35.71	408
Central Idaho Angling	257	na	129,026	37.68	4,862
Total	1,449	na	640,685	na	38,524

Note:
The number of trips and the WTP per trip were estimated based on each survey. The surveys asked how many trips each individual takes a year and how much each trip costs. This travel cost is used to compute an individual's WTP for recreation. Annual benefits are calculated by multiplying the number of trips by the WTP per trip.

that they would be most likely to visit. A total of 4,780 completed surveys were returned for a response rate of 54 percent. The survey findings were then applied to all Washington, Idaho, Oregon, western Montana, and California residents. The results of this survey indicate that a large percentage of total river recreation trips would come from more distant areas such as Portland, Seattle, and California. This differs from current conditions where are large proportion of outdoor recreationists and anglers reside within 50 miles of the four reservoirs.

Four different demand estimates and two estimates of WTP per trip were generated for Alternative 4, Dam Breaching. Annual trips to a free-flowing lower Snake River were estimated to range from 245,338 to 1,756,193 by the tenth year following breaching. Recreation use following dam breaching would be phased in over time as the natural river system recovered from breaching. Use would also be constrained by existing facilities — developed campgrounds, dispersed campgrounds, and boat ramp capacity. Facilities were, however, projected to increase over time as river conditions stabilized. Salmon and steelhead fishing demand would be constrained by the availability of fish, and only a small fraction of projected angler demand would be met.

The average annual effects are presented for Alternatives 2 through 4 in Table ES-4. These values, presented in 1998 dollars, represent the net change from Alternative 1, Existing Conditions. These data indicate that there are significant recreation benefits associated with breaching the dams. The data also indicate that the majority of these benefits would be associated with recreation activities other than fishing. However, benefits associated with fishing alone would replace a large portion of the reservoir recreation benefits that would be lost under this alternative. There would also be benefits associated with small projected gains in salmon and steelhead fishing under Alternatives 2 and 3.

The low estimates presented for Alternative 4, Dam Breaching, are consistent with values in the literature for general recreation, while the high estimates are consistent with literature for river angling. As a result, the Corps believes that the most likely point estimates would be a composite of the low and high estimates. These composite values are presented as the point estimates in Table ES-4.

ES.2.3 Transportation

Alternative 4, Dam Breaching, would have significant effects upon navigation because barges would no longer be able to operate. Commodities currently transported by barge on the lower Snake River would need to be shipped by rail or truck. The DREW Transportation Workgroup conducted a transportation analysis as part of this study to identify and quantify the direct economic effects resulting from disruption of the existing transportation system. This analysis was designed to measure the effect that breaching the four lower Snake River dams would have on the costs of transporting products that are currently shipped on the Columbia-Snake Inland Waterway.

The economic effects of the loss of navigation are addressed in terms of costs associated with both current and projected future traffic volumes. Alternative routings for existing and projected lower Snake River shipments were identified based on origin and destination data compiled for each shipment. Commodities could, in most cases, either be rerouted via truck to river elevators located on McNary pool or shipped by rail directly to export elevators on the lower Columbia River. Where rail access is currently available at country elevators, grain could either shift to rail direct from these locations, or be moved by truck to a rail distribution point where unit trains could be assembled. The costs of transportation, storage, and handling were calculated for the alternative routings of each affected origin-destination pair.

The DREW Transportation Workgroup analysis measured direct economic effects in terms of opportunity costs rather than market rates. In other words, the costs developed in this analysis assume a perfectly competitive market and do not take into account possible increases in rail and truck transportation rates that may occur in the absence of navigation. It was also assumed that current and projected levels of exports from the region would continue under the dam breaching scenario.

The average annual effects are presented for Alternative 4, Dam Breaching, in Table ES-5. These values, presented in 1998 dollars, represent the net change from Alternatives 1 through 3, which serve as the base case for this analysis. These data indicate that the majority of the average annual cost increase—about 83 percent—would be associated with grain.

ES.2.4 Water Supply

The DREW Water Supply Workgroup addressed the effects of the dam breaching alternative on agricultural water users, municipal, industrial, and other uses, and privately owned wells. Only Alternative 4, Dam Breaching, would directly affect the operation of river pump station and wells used for irrigation and other uses. Approximately 37,000 acres of irrigated farmland currently rely on water pumped from Ice Harbor Reservoir. Additional farmland is irrigated by private wells. The cost of modifying the Ice Harbor pumping stations to provide current water supplies following dam breaching would be more than twice the value of the land they currently irrigate. The value used for this analysis is the change in the value of the land if it were no longer irrigated.

Table ES-4. Recreation and Tourism - Average Annual Economic Effects by Discount Rate, (1998 Dollars) ($1,000s)

	6.875 % Discount Rate		4.75 % Discount Rate		0.0 % Discount Rate	
	Minimum	**Maximum**	**Minimum**	**Maximum**	**Minimum**	**Maximum**
Alternative 2						
Reservoir Recreation	0	0	0	0	0	0
River Recreation	0	0	0	0	0	0
Recreational Fishing	2,030	2,030	1,990	1,990	1,420	1,420
Total	**2,030**	**2,030**	**1,990**	**1,990**	**1,420**	**1,420**
Total Point Estimate		**2,030**		**1,990**		**1,420**
Alternative 3						
Reservoir Recreation	0	0	0	0	0	0
River Recreation	0	0	0	0	0	0
Recreational Fishing	2,080	2,080	1,970	1,970	1,180	1,180
Total	**2,080**	**2,080**	**1,970**	**1,970**	**1,180**	**1,180**
Total Point Estimate		**2,080**		**1,970**		**1,180**
Alternative 4						
Reservoir Recreation	-31,600	-31,600	-31,600	-31,600	-31,600	-31,600
River Recreation	36,180	150,120	38,100	158,300	44,000	182,600
Recreational Fishing	6,746	32,916	8,220	37,440	12,750	52,220
Total	**11,326**	**151,436**	**13,246**	**159,616**	**19,146**	**183,916**
Total Point Estimate		**82,000**		**86,000**		**102,000**

Notes:
1. Benefits are presented net of Alternative 1, Existing Conditions, which is considered the base case for this analysis.
2. The recreational fishing category includes mainstem salmon, resident, and steelhead species and tributary salmon and steelhead species.

Table ES-5. Transportation - Average Annual Economic Effects by Discount Rate, (1998 Dollars) ($1,000s)

Alternative 4	**6.875 % Discount Rate**	**4.75 % Discount Rate**	**0.0 % Discount Rate**
Grain	(22,566)	(22,731)	(23,156)
Non-Grain Commodities	(4,624)	(4,710)	(4,904)
Total	(27,190)	(27,441)	(28,060)
Adjusted Total[1/]	(23,804)	(25,008)	(028,060)

1/ The DREW Transportation Workgroup analysis used 2007 as the base year. These are the first set of average annual values. The adjusted totals discount the same stream of costs back to 2005 to allow comparability with other elements of the study.

The Municipal and Industrial (M&I) pump stations that withdraw from the lower Snake River are all located on the Lower Granite Reservoir. Uses include municipal water system backup, golf course irrigation, industrial process water for paper production, and concrete aggregate washing. The values used for this analysis are based on the costs required to modify these systems. There is a range of costs because it is unknown what modifications would be necessary for the Potlatch Corporation's Lewiston facility. There are also approximately 209 functioning wells within 0.6 km (1 mile) of the lower Snake River. The Corps estimates that about 40 percent, or 95, of these wells would require modification if dam breaching were to occur.

The total cost of modifying these existing water withdrawal systems is summarized by category in Table ES-6. Average annual costs would range from $13,919,500 to $16,927,800 using a 6.875 percent discount rate. Using a 0.0 percent discount rate would result in average annual costs that range from $2,021,900 to $2,458,900.

Table ES-6. Water Supply - Summary of Economic Effects and Average Annual Economic Effects by Discount Rate, 1998 Dollars ($1,000s)

Alternative 4 Water Supply Category	Economic Effect	Average Annual (6.875% Discount Rate)	Average Annual (4.75% Discount Rate)	Average Annual (0.0% Discount Rate)
Loss of Irrigated Farmland Value	(134,240)	(9,241.1)	(6,438.1)	(1,342.4)
Municipal and Industrial Pump Stations	(11,514) to (55,214)	(792.6) to (3,800.9)	(552.2) to (2,648.1)	(115) to (552)
Privately Owned Wells	(56,447)	(3,885.8)	(2,707.2)	(564.5)
Total	**(202,201) to (245,901)**	**(13,919.5) to (16,927.8)**	**(9,697.5) to (11,793.4)**	**(2,021.9) to (2.458.9)**

ES.2.5 Anadromous Fish

The anadromous fish analysis conducted by the DREW Anadromous Fish Workgroup identified the net economic costs associated with changes in commercial and ocean recreational anadromous fish harvest. Projected changes in fish harvest are based on preliminary data developed through the committee-based process Plan for Analyzing and Testing Hypotheses (PATH). PATH provided data for seven index stocks for Snake River spring/summer chinook, a comprehensive review of Snake River fall chinook, and a narrative description evaluating the correlation between Snake River spring/summer chinook and steelhead. In order to analyze the economic effects of future harvests under the different alternatives, the DREW Anadromous Fish Workgroup expanded the PATH results to represent all Snake River wild and hatchery stocks. This economic analysis considered commercial and recreational harvesting of wild- and hatchery-originating fish and also sales of hatchery returns for egg, carcass, and food fish. Commercial and ocean recreational harvests were allocated to user groups and geographic areas based on existing U.S. and Indian tribal agreements. Fish available after these obligations are met were distributed based on historical harvest distributions. Commercial economic values are based on ex-vessel values, while the recreational fishery value is based on a value per angler day.

The changes in NED values associated with changes in anadromous fish harvest are calculated as annual average values over a 100-year period of analysis and presented net of the base case (Alternative 1, Existing Conditions). These average annual values are presented for Alternatives 2 through 4 using three different discount rates presented in Table ES-7. Using a 6.875 percent discount rate, NED benefits range from $0.16 million for Alternatives 2 and 3 to $1.59 million for Alternative 4, Dam Breaching. If a zero discount rate is used, the average annual benefits may be as high as $3.49 million. Most of the totals shown here would be generated from the in-river treaty fishery contributed by fall chinook. There would also be significant NED benefits associated with the in-river recreational fishery. These benefits are included in the analysis conducted by the DREW Recreation Workgroup (see Section 2.2). In-river recreational fishing values are not included in the totals presented in Table ES-7.

Table ES-7. Anadromous Fish - Average Annual Economic Effects by Discount Rate, (1998 Dollars) ($1,000s)

		6.875 % Discount Rate	4.75 % Discount Rate	0.0 % Discount Rate
Alternative 2				
Commercial	Ocean	0	0	0
	Inriver	159.77	175.53	197.63
Recreational	Ocean	0	0	0
Total		159.77	**175.53**	**197.63**
Alternative 3				
Commercial	Ocean	12.34	14.98	23.1
	Inriver	145.53	154.95	158.79
Recreational	Ocean	3.46	4.21	6.49
Total		161.33	**174.14**	**188.38**
Alternative 4				
Commercial	Ocean	380.65	476.98	735.9
	Inriver	1105.8	1452.7	2543.08
Recreational	Ocean	106.95	134.01	206.76
Total		**1593.4**	**2063.69**	**3485.74**

ES.2.6 Tribal Circumstances

There are 14 Native American tribes and bands in the region that potentially could be affected by the actions taken to improve fish passage and survival along the lower Snake River. They are as follows:

- Confederated Tribes of the Colville Indian Reservation
- Confederated Tribes of the Umatilla Indian Reservation
- Confederated Tribes and Bands of the Yakama Nation
- Nez Perce Tribe
- Wanapum Band
- Burns Paiute Tribe
- Coeur d'Alene Tribe
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Kalispel Indian Community of the Kalispel Reservation
- Kootenai Tribe of Idaho
- Northwestern Band of the Shoshoni Nation
- Shoshone-Bannock Tribes of the Fort Hall Reservation
- Shoshone-Paiute Tribes of the Duck Valley Reservation
- The Spokane Tribe of the Spokane Reservation.

Five of these tribes — the Nez Perce Tribe (Nez Perce), the Confederated Tribes of the Umatilla Reservation (Umatilla), the Yakama Indian Nation (Yakama), the Confederated Tribes of the Warm Springs Reservation of Oregon (Warm Springs), and the Shoshone-Bannock Tribes (Shoshone-Bannock) — were selected for specific input because of their close cultural and economic links to the salmon. A Tribal Circumstances and Perspectives Report was prepared by a private consultant in association with the Columbia River Inter-Tribal Fisheries Commission (CRITFC) (Meyer Resources, 1999). According to this report, the ancestors of these five tribes (referred to as the study tribes) historically valued the salmon first for cultural and spiritual purposes — and then to feed their people. Salmon were also traded and exchanged for other valued goods, both within each tribe, and with peoples from other tribes.

As the salmon have declined, the surpluses available to the tribes for trading and commercial sale — after ceremonial and subsistence needs are met — have declined toward zero. The Tribal Circumstances and Perspectives Report notes that even ceremonial needs are not met for most of the study tribes.

The study tribes emphasize that while revenue obtained from commercial sales of salmon provides important income to tribal peoples it does not represent the greatest part of value that tribal peoples associate with salmon. The study tribes consider dollar revenue to be a severely limited indicator of tribal value that can provide a distorted impression of full impact to the tribes. Tribal circumstances are, as a result, addressed qualititatively in this analysis (see Section 4 of this summary). Dollar values are, however, assigned to tribal commercial fish harvest as part of the NED economic analysis conducted by the DREW Anadromous Fish Workgroup (see Section 2.5 of this summary).

ES.2.7 Flood Control

Flood control benefits are not currently provided by the lower Snake River dams. Flood control benefits would also not be provided if dam breaching were to occur. As a result, there are no NED costs or benefits associated with this resources area.

ES.2.8 Implementation/Avoided Costs

Implementation costs considered in the following discussion include all project-related construction and acquisition costs and operation, maintenance, repair, replacement and rehabilitation costs (O,M,R,R&R) associated with construction and operation activities required under each alternative. The major cost categories include:

- Construction costs for fish-improvement projects and/or breaching the dams. Construction costs associated with the dam breaching alternative include mitigation costs, such as wildlife mitigation and cultural resources protection and mitigation, at each of the four dams
- Interest during construction (IDC), which reflects compound interest at the applicable borrowing rate, on construction costs incurred during the period of installation
- Anadromous fish evaluation program (AFEP)
- O,M,R,R&R costs associated with the new fish improvement projects (e.g., purchase of water from the Bureau of Reclamation (BOR) and the O&M costs associated with the screen bypass system proposed under Alternative 3, Major System Improvements).

Average annual costs are presented in Table ES-8. These costs vary depending upon which discount rate is used but the ranking of the alternatives remains constant. Alternative 2, Maximum Transport of Juvenile Salmon, is the lowest cost alternative, while Alternative 4, Dam Breaching, is the highest cost alternative, under all discount rates.

Table ES-8. Implementation Costs - Average Annual Economic Effects, 1998 Dollars ($1,000s)

	6.875 % Discount Rate	4.75 % Discount Rate	0.0 % Discount Rate
Alternative 2			
Investment Cost	1,604	1,087	214
AFEP Cost	1,853	1,469	449
O.M.R.R & R Cost	0	0	0
Total	**3,457**	**2,556**	**663**
Alternative 3			
Investment Cost	(4,818)	3,402	731
AFEP Cost	(420)	333	101
O.M.R.R & R Cost	(693)	641	558
Total	**(5,931)**	**4,376**	**1,390**
Alternative 4			
Investment Cost	(48,982)	(35,525)	(8,218)
AFEP Cost	3,028	2,401	733
O.M.R.R & R Cost	(2,833)	(2,374)	(813)
Total	**(48,787)**	**(35,498)**	**(8,298)**

The avoided costs associated with each alternative include those costs that would no longer be required to operate and maintain the lower Snake River dams and associated lands. These costs are calculated by comparing the continued operation of the four lower Snake River lock and dams under Alternative 1, Existing Conditions, with Alternatives 2 through 4. Costs required under Alternative 1 that are not required under the other alternatives are considered avoided costs.

Avoided costs include:

- Costs of construction or major upgrades that would occur with Alternative 1, Existing Conditions, but not under other alternatives. These include major powerhouse system upgrades and specific additional major improvements to fish bypass, collection, and passage systems

- O&M costs incurred under Alternative 1, Existing Conditions, but not under other alternatives. These include future annual O&M costs and additional annual repair costs.

Disposition of equipment that could be surplused if the dams were breached represents a third type of cost included in this analysis. This represents a reduced opportunity cost for other Federal agencies seeking this type of property and may, therefore, be considered a form of avoided costs.

The avoided costs associated with Alternative 4, Dam Breaching, are approximately $29 million per year over the life of the study, under all three discount rates, as shown in Table ES-9.

Table ES-9. Avoided Costs - Average Annual Economic Effects, 1998 Dollars ($1,000s)

	6.875 % Discount Rate	4.75 % Discount Rate	0.0 % Discount Rate
Alternative 2			
Turbine Rehabilitation	0	0	0
Non-Project Related O.M.R.R & R Cost	0	0	0
Surplus Property	0	0	0
Total	**0**	**0**	**0**
Alternative 3			
Turbine Rehabilitation	0	0	0
Non-Project Related O.M.R.R & R Cost	(7)	(23)	(477)
Surplus Property	0	0	0
Total	**(7)**	**(23)**	**(477)**
Alternative 4			
Turbine Rehabilitation	4,800	4,579	3,871
Non-Project Related O.M.R.R & R Cost	23,350	24,048	25,030
Surplus Property	1,028	716	149
Total	**29,178**	**29,343**	**29,050**

ES.2.9 Summary

The total NED costs and benefits identified in this analysis are presented in Table ES-10. These costs presented net of Alternative 1, Existing Conditions, were calculated for a 100-year period of analysis extending from 2005 to 2104. The values presented in this table were discounted using a 6.875 percent discount rate and converted into 1998 dollars.

NED costs are:

- Implementation costs for fish-related improvements (Alternatives 3 and 4)
- Cost increases associated with the shift from hydropower to more expensive forms of replacement power
- Transportation cost increases associated with the shift of barge-transported commodities to more costly truck and rail systems
- Costs incurred as a result of impacts to users presently withdrawing water from the lower Snake River reservoirs

Table ES-10. Summary - Average Annual Economic Effects, 1998 Dollars ($1,000s of dollars)

Costs	Alternative 2	Alternative 3	Alternative 4
Implementation Costs	-	(5.931)	(48.787)
Power	-	-	(271.000)
Transportation	-	-	(24.034)
Irrigation/Water Systems	-	-	(15.424)
Total Costs	-	(5.931)	(359.245)
Benefits			
Avoided Costs	-	-	29.178
Recreation	2,030	2,080	82.000
Anadromous Fish	160	161	1,593
Implementation Costs	3.457	-	-
Power	8,500	8.500	-
Total Benefits	14,147	12,982	112,771
Total Costs — Benefits (net)	**14,147**	**4,810**	**(246,474)**

Notes:
1. These costs and benefits, calculated for a 100-year period of study extending from 2005 to 2104, are discounted using a 6.875 percent discount rate and converted to 1998 dollars.
2. Costs and benefits are presented for Alternatives 2 through 4 net of the base case (Alternative 1).
3. A positive monetary value indicates that the alternative being evaluated has a lower cost or greater benefit than Alternative 1. A negative monetary value indicates that the evaluated alternative has a higher cost or lower benefit than Alternative 1. Positive monetary values, therefore, represent benefits, while negative values represent costs.

NED benefits are:

- Costs incurred under Alternative 1, Existing Conditions, that would be avoided under the other alternatives. These include operations, maintenance, repair, and replacement costs, as well as the costs associated with the rehabilitation of existing infrastructure
- Recreation benefits from increased fish runs and the shift to a free-flowing river
- Commercial fishing benefits from increased fish runs
- Implementation costs for fish-related improvements (Alternative 2)
- Power benefits (Alternatives 2 and 3)

This summary indicates that Alternative 4, Dam Breaching, has significantly higher average annual net costs that the other alternatives. Alternatives 2 and 3 are actually less costly than Alternative 1. This is mainly because of increased power benefits. The largest NED average annual cost component associated with Alternative 4, Dam Breaching, is the cost associated with power replacement ($271 million). The second largest average annual costs, implementation costs, are lower than 20 percent of the average annual power costs. Significant in-river average annual recreation benefits ($82 million) are also associated with this alternative.

ES.3 Passive Use Value Estimates

Economists generally recognize that there is a benefit associated with knowing that the resource exists, even if no use is made of it. These values are typically referred to as passive use, non-use, or existence values. There are, however, disagreements about how to measure passive use values. Although DREW originally requested that a passive-use survey be conducted by the DREW Recreation Workgroup, the passive-use analysis conducted for this study used a benefit transfer approach. It should be noted that passive-use values are not NED benefits.

The passive use value estimates for salmon were calculated on a per fish basis based on the preliminary PATH results, as extended by the DREW Anadromous Fish Workgroup. Values were calculated for Alternatives 2 through 4 net of Alternative 1. Using the 1998 model results, the average annual return of wild salmon is less under Alternatives 2 and 3 than under Alternative 1, Existing Conditions. This resulted in negative passive use values for these alternatives. The passive use value associated with Alternative 4, Dam Breaching, was estimated to range from $66 million to $879 million per year, with a middle range between $142 and $508 million per year. The passive use value of a free flowing lower Snake River was estimated at $420 million per year.

Using the 1999 PATH model results would reduce the difference among Alternatives 1 through 3 and Alternative 4, Dam Breaching. This would lower the estimated passive use value for Alternative 4, which, as noted above, is calculated net of Alternative 1, Existing Conditions. However, the passive use values associated with the free flowing river would not change.

ES.4 Tribal Circumstances and Perspectives

This section pulls information from a number of sources. One specific source of tribal information is the Tribal Circumstances and Perspectives Report (Meyer Resources, 1999). The Tribal Circumstances and Perspectives Report focuses on input from specific tribes and sets forth their perspectives. The specific tribes which participated are the Nez Perce, Umatilla, Yakama, Warm Springs, and Shoshone-Bannocks.

The Tribal Circumstances and Perspectives Report assesses impacts to tribal circumstances in terms of: tribal ceremonial, subsistence, and commercial harvests of salmon and steelhead and tribal access to flooded lands valuable to tribes. The analysis of salmon recovery and harvest levels presented in the Tribal Circumstances and Perspectives Report is based on preliminary numbers.

PATH measured the effect of the proposed alternatives on seven index salmon stocks for Snake River spring/summer chinook, a comprehensive review of Snake River fall chinook, and a narrative description evaluating the correlation between Snake River spring/summer chinook and steelhead.

The following discussion of alternatives presented below is based on preliminary PATH data weighted by PATH's panel of independent experts and extended by the DREW Anadromous Fish Workgroup to represent all Snake River wild and hatchery stocks. The Tribal Circumstances and Perspectives report presents tribal harvest recovery rates based on this preliminary PATH data and converts these rates into pounds, assuming average weights of 20.1 pounds per salmon for spring and summer chinook, 19.1 pounds per salmon for fall chinook, and 8.5 pounds per fish for steelhead. Results were evaluated at the 30-year and 50-year benchmarks. Due to concerns associated with the weighting process, unweighted PATH results were used in all other analyses for this feasibility study.

The Tribal Circumstances and Perspectives Report asserts that Alternatives 1 and 2 offer limited hope of salmon recovery within a timeframe considered reasonable by the five represented tribes. The report does not address Alternative 3, but the impacts for this alternative are likely to closely match those for Alternative 2. There would be no change in tribal land use under any of these alternatives.

According to the Tribal Circumstances and Perspectives Report, Alternative 4, Dam Breaching, would produce 2.4 times more tribal harvest of Snake River wild salmon and steelhead stocks than Alternative 1 (2.6 times more harvest than Alternative 2). At the 50-year benchmark, estimated tribal wild and hatchery harvest would increase by about 1.7 million pounds. The Tribal Circumstances and Perspectives Report concludes that only this alternative would redirect river actions toward significant improvement of the cultural and material circumstances of the tribes.

Approximately 14,000 acres of previously inundated land would be exposed under Alternative 4. The Tribal Circumstances and Perspectives Report states that the tribes would benefit greatly from implementation of this alternative by gaining access to lands once used for cultural, material, and spiritual purposes.

ES.5 Regional Economic Development (RED)

The regional economic analysis (RED) developed for this study addresses the regional economic impacts of changes in spending projected by various DREW workgroups. These impacts, evaluated in terms of business sales, employment, and income, were estimated using input-output models, which model the interactions among different sectors of the economy. Eight models were constructed to address the potential regional effects associated with the alternatives. Models were developed for Washington, Oregon, Idaho, and Montana, three subregions — the downriver, reservoir, and upriver subregions, and the lower Snake River study area, which consists of the three subregions. In addition, the DREW Anadromous Fish Workgroup estimated the economic impacts of changes in anadromous fish harvests. These impacts were evaluated for the Pacific Northwest states, Alaska, and British Columbia, Canada.

Construction activities resulting directly and indirectly from breaching of the four lower Snake River dams would generate increased business sales of $2,263 million, 20,790 temporary jobs, and $676.7 million in personal income in the lower Snake River study area. These changes would occur within 10 years of dam breaching and would fluctuate from year to year. In the long run, the lower Snake River study would experience a net decrease in business sales of $33.7 million, a loss of 711 jobs, and a decrease of $46.1 million in personal income. Short- and long-term changes in lower Snake River study area employment are presented by resource area and study region in Tables ES-11 and ES-12.

Impacts would also occur throughout the Pacific Northwest, throughout a state, or in an area of a State outside a subregion. These impacts include reductions in business sales, employment, and personal income associated with increased electricity bills. Positive impacts would be associated with replacement power plant construction and operations in the Puget Sound region, construction of tidewater rail care storage in Oregon, and increases in commercial and ocean recreation harvest of anadromous fish in the Pacific Northwest states, Alaska, and British Columbia, Canada.

Table ES-11. Short-Term Employment Effects (Jobs)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area2/
1995 Employment	75,081	92,535	151,124	318,740
Power Plant Construction[3/]	0	0	5,572	5,572
Transmission Line Construction	0	0	2,080	2,080
Rail Construction[4/]				872
Road Construction[4/]				1,972
Facilities Construction[4/]				6,982
Well Modification	0	916	259	1,175
Pump Modification	844	0	0	844
Implementation	259	517	517	1,293
Total Change[5/]	**1,103**	**1,433**	8,428	**20,790**
Change as % of 1995 Employment	1.47	1.55	5.58	6.52

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years. Many impacts have a wide range of variation depending on the magnitude of construction and the length of the time period.

2/ The three subregions comprise the lower Snake River study area. Employment change in this area includes the sum of employment change across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.

3/ The DREW Hydropower Impact Team (DREW Hydropower Impact Team) assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown, but DREW Hydropower Impact Team assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate 2,786 short-term jobs. The estimates shown in this table are the maximum number of these jobs that would be generated in any one year—5,572 in the downriver subregion, where two plants would be constructed simultaneously.

4/ These effects would occur in the lower Snake River study area, but it is unknown how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

Table ES-12. Long-Term Employment Effects (Jobs) [1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2]
1995 Employment	75,081	92,535	151,124	318,740
O&M Spending on Replacement Power Plants & New Transmission Lines	0	0	884	884
Recreation (incl. angling) [3/]				1,393
Total Long-Term Employment Gain[4/]	**0**	**0**	**884**	**2,277~**
Reduction in Irrigated Lands	0	(1,105)	(474)	(1,579)
Avoided Costs (Reductions in Corps' Spending)	(133)	(1,060)	(133)	(1,326)
Reduced Cruise Ship Operations	(83)	0	0	(83)
Total Long-Term Employment Loss	**(216)**	**(2,165)**	**(607)**	**(2,988)**
Net Long-Term Employment Change[4/]	(216)	(2,165)	277	(711)
Net Change as a % of 1995 Employment	(0.29)	(2.34)	0.18	(0.22)

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.

2/ The three subregions comprise the lower Snake River study area. Employment change in this area is the sum of employment change across the three subregions. Some of the projected Snake River study area impacts were not distributed by subregion.

3/ These effects would occur in the lower Snake River study area, but it is unknown how they would be distributed among the subregions.

4/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the Study Area impacts were not distributed by subregion.

ES.6 Social Analysis

The DREW Social Analysis examined nine focus communities — Clarkston, Colfax, Kennewick, Pasco, and Pomeroy in Washington; Lewiston, Orofino, and Riggins in Idaho; and Umatilla in Oregon. These communities were selected to capture a range of positive and negative impacts across different types of communities located throughout the region. These nine focus communities are divided evenly over the three subregions that comprise the lower Snake River study area. The following discussion addresses potential impacts that are likely to be common to other communities located in their respective subregions.

Alternative 1, Existing Conditions, is considered the base case for this analysis. Alternatives 2 and 3 would have little effect on the existing social and economic environment for most of the communities located in the lower Snake River region. Some communities, particularly those located upriver (e.g., Lewiston, Orofino, and Riggins), could be adversely affected by lower probabilities of salmon recovery. Uncertainty about the future of the four lower Snake River dams may also have negative social effects on some communities.

Breaching the four lower Snake River dams would change the physical and economic environment of the Lower Snake River study area. Communities in the upriver region (e.g., Lewiston, Orofino, and Riggins) would likely experience net employment gains as a result of expected increases in recreation and tourism associated with a free-flowing river, and to a lesser extent increased fish runs. The extent of the effects upon Lewiston and Orofino are, however, uncertain because the possible effects that the loss of river navigation could have upon the forest products industry have not been completely analyzed. Detailed industry studies would be needed to fully evaluate the extent of these effects. The effects of increased transportation costs to farmers would be most significant for communities located in the upriver subregion. Communities in Latah, Nez Perce, Idaho, and Lewis counties in Idaho would experience the largest increases in transportation costs.

Communities located in the reservoir subregion (e.g., Pomeroy, Colfax, and Clarkston) would likely experience a net decrease in employment due to reductions in Corps' employment and increased pressure on family farms caused by increased transportation, storage, and handling costs for agricultural products. This added pressure to an already depressed agricultural sector may lead to an increased rate of farm consolidation for those farms with a high debt to equity ratio.

Communities located in the downriver subregion (e.g., Pasco, Kennewick, and Umatilla) would likely experience employment loss if farms presently irrigated from Ice Harbor reservoir go out of business. These losses could be partially offset by expected increases in transportation- and power-generation-related employment.

Overall adverse community impacts associated with Alternative 4, Dam Breaching, that were identified by the DREW Social Analysis Workgroup include:

- Decreased net farm income and increased financial pressure on dryland farmers throughout the region, particularly those farms located close to the lower Snake River
- Risk of increased consolidation of family farms and a decrease in rural farm population
- Decreased county property tax base in 20 regional counties from decreased farm land value and potential loss of irrigated lands

- Dislocated full-time and seasonal workers from Ice Harbor irrigated agricultural lands and a loss of a source of local school revenue for communities close to the reservoir
- Realignment of communities' economic bases and changed potential for future growth

Communities would likely adjust to these changes. New individuals and businesses seeking new opportunities may replace those that have been displaced. Displaced human and capital resources may be employed in their next best use within the community. This type of adjustment does, however, take time and would vary by community. Community size has been identified as a critical factor affecting a community's ability to adapt to change, with smaller, less diverse communities tending to respond less favorably.

ES.7 Uncertainty

Uncertainty is inherent in any future-oriented planning effort. The period of analysis for this economic study is 100 years. Considerable uncertainty surrounds any attempt to forecast results 100 years into the future. In general, elements of uncertainty affect everything we do. It is the reality of inadequate information. When information is imprecise or absent, that is uncertainty. From this perspective, uncertainty is present in all aspects of the lower Snake River Juvenile Salmon Migration Feasibility Study. The plan formulation, the biology, and the economics all have elements of uncertainty in their analyses. Uncertainty of this type surrounds key study assumptions, methodology, and data collection in all resource areas.

The economic analysis presented in this appendix addresses the role of uncertainty in two ways. First, each study team was asked to address risk and uncertainty issues in their analyses. Second, an overall risk and uncertainty assessment of the economic and social analyses presented here was conducted as a separate part of the DREW process. The primary source of information for this risk and uncertainty assessment was information provided by the DREW study teams.

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1. Introduction

1.1 Purpose of the Economic Appendix

The purpose of this appendix is to measure the economic and social effects of the alternatives proposed under the Lower Snake River Juvenile Salmon Migration Feasibility Study. Section 102 of the National Environmental Policy Act (NEPA) and Council on Environmental Quality (CEQ) guidelines, which interpret NEPA, require that economic and social effects be identified. Evaluation of these effects is critical to decision makers and also important to others interested in the outcome of this feasibility study. The evaluation presented in this document uses economic measures to evaluate efficiency changes in the nation's production of goods and services. This evaluation is designed to identify the gains and losses to society as a whole. The effects that the proposed alternatives would have upon the region and specific groups of individuals are also examined. The overall structure of this analysis is discussed in more detail in Section 1.3 below.

The economic and social effects of each proposed alternative are evaluated for the primary uses of the lower Snake River, which include electric power generation, recreation, transportation, and water supply. Economic effects are typically stated in monetary terms. In some cases, where monetary measures are not available, qualitative assessments are used.

1.2 Study Area

The geographic scope of the economic analysis conducted for the FR/EIS is consistent with the analysis of the physical effects of the proposed alternatives. The actions proposed under the selected alternative would be implemented, as appropriate, at each of the four run-of-river dams along the lower Snake River. In general, the economic effects were evaluated wherever significant physical effects were identified. In the case of the transportation analysis, for example, the study area includes grain-producing areas, as well as river origins and destinations for other commodity groups that are transported via the lower Snake River. The social analysis is, however, primarily limited to a series of focus communities intended to provide decision makers with information concerning potential impacts across a range of different communities. A regional base map that shows the location of the four lower Snake River dams and the surrounding region is presented in the foreword to this appendix.

1.3 Structure of Analysis

The structure of the economic and social analysis developed for this FR/EIS is based upon the *Economic and Environmental Principles and Guidelines for Water and Related Land Resources Implementation Studies* developed by the U.S. Water Resources Council (WRC) (WRC, 1983). These guidelines recommend that the evaluation and display of the effects of proposed alternatives be organized into four accounts:

- The national economic development (NED) account, which displays changes in the economic value of the national output of goods and services
- The environmental quality (EQ) account, which displays nonmonetary effects on significant natural and cultural resources

- The regional economic development (RED) account. which addresses changes in the distribution of regional economic activity
- The other social effects (OSE) account, which addresses potential effects from relevant perspectives that are not reflected in the other three accounts

The NED account is the only account required under the WRC guidelines. The guidelines recommend that other information that is required by law or that will have a material bearing on the decision-making process should be included in one of the other accounts (EQ. RED. or OSE) or in some other appropriate format. The four accounts and their relationship to this analysis are discussed in the following sections.[1]

1.3.1 National Economic Development (NED)

The NED account addresses the net effects of a proposed action upon the nation. NED analysis is concerned only with economic efficiency at the national level. Economic gains achieved by one region at the expense of another region are not measured as NED benefits. This is because the Federal objective in water resources planning is national economic development. If a Federal project induces a firm to leave one region for another, the increase in regional income for the host region may well be a benefit to that area. However, from a national perspective, if the impacts to the new host region are included as a benefit, then the loss of income to the former host region must be included as a project cost. In most cases, this type of gain to one region is another region's loss, and the two effects represent a transfer of income that cancels out any net change. As a result, NED analysis does not consider these types of transfers. Regional impacts are instead addressed under the RED account, which is discussed in Section 1.3.3 below.

Beneficial effects measured under the NED account include increases in the economic value of the national output of goods and services, the value of output resulting from external economies caused by the proposed alternative, and the value associated with the use of otherwise unemployed or under-employed labor resources. External economies may be defined as benefits generated outside of a market transaction. Individuals may benefit from these types of external economies without having to reimburse the party responsible for the positive effect.

Adverse NED effects are usually the opportunity costs of resources used in implementing a plan. All resources are scarce, and we must choose when to use them. Choose more of one thing, and we simultaneously choose less of another. If we make the best choice from a number of alternative uses of a river reach, at a minimum it costs us the opportunity to do the next best thing with the reach The NED account distinguishes among implementation outlays, associated costs, and other direct costs. Implementation outlays are the financial outlays, including operation, maintenance, and replacement costs, incurred for implementation of the plan. Associated costs are those required in addition to implementation outlays. These are typically costs for measures needed to achieve project benefits. Other direct costs represent the uncompensated and unmitigated costs of resources that are affected by the project or plan.

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[1] This discussion of the four accounts is drawn from the WRC guidelines (WRC, 1983) and supplemented by additional material from the *National Economic Development Procedures Manual—Overview Manual for Conducting National Economic Development Analysis* (IWR Report 91-R-11). The interested reader is referred to these documents for additional information.

The general measurement standard for the value of goods and services is defined as the willingness of users to pay for each increment of output associated with a proposed alternative. Since it is not usually possible to obtain willingness to pay values, alternative or proxy measures are used. These measures include actual or simulated market price, change in net income, cost of the most likely alternative (e.g., replacement cost of hydropower), and administratively established values.

The NED analysis presented here addresses power, recreation, transportation, water supply, anadromous fish, tribal circumstances, flood control, and implementation/avoided costs. A net gain in recreation use under Alternative 4, Dam Breaching, is an example of an NED benefit in this case. Beneficial NED effects are also associated with increased commercial fishing under this alternative. The loss of hydropower and the associated increase in the cost of generating electricity are examples of NED costs associated with Alternative 4, Dam Breaching. Another example of an NED cost associated with the dam breaching alternative is the net increase in transportation costs for commodities that are presently shipped on the lower Snake River.

The application of the NED analysis to each resource area is presented in Section 3.0 of this appendix.

1.3.2 Environmental Quality (EQ)

The EQ account provides a means of displaying and integrating qualitative information on the effects of proposed alternatives on significant resources and attributes of the human environment (WRC, 1983). Beneficial and adverse effects in the EQ account address changes in the ecological, aesthetic, and cultural attributes of natural and cultural resources.

The Tribal Circumstances and Perspectives report developed for this analysis by Meyer Resources, Inc. in association with the Columbia River Inter Tribal Fisheries Commission (CRITFC) suggests that tribal circumstances and effects should be incorporated into the economic assessment under the EQ account. While tribal assessments carried out by Federal agencies tend to concentrate on historic cultural resources, primarily sites and artifacts, the Tribal Circumstances and Perspectives report indicates that existing tribal communities and groups should also be considered under the definition of cultural resources.

The Tribal Circumstances and Perspectives report also suggests that the tribal effects analysis contains some information identified by the WRC guidelines as part of the OSE account—particularly with regard to the issues of Tribal health and displacement. Tribal circumstances are discussed qualitatively in Section 5.0 of this appendix. Tribal circumstances are also briefly addressed in the context of the NED analysis in Section 3.6.

1.3.3 Regional Economic Development (RED)

The RED account addresses the changes in regional economic activity that would result from each alternative. Two measures typically used in RED analysis to assess the effects on regional economies are income and employment. The regional analysis presented in this document addresses changes in income and employment. It also includes a third measure—business sales volume. The regions typically used for RED analysis are those that would experience particularly significant project-related income and employment effects.

The regional analysis presented in this document measures regional effects using input-output models. This analysis, developed by the DREW Regional Analysis Workgroup, is primarily based

on estimates of direct economic effects generated by other DREW workgroups as part of the NED analysis. Most effects associated with the proposed alternatives would occur in the lower Snake River region. This region is the primary focus of the regional analysis. Four input-output models were developed to assess the regional impacts of these effects. County data were aggregated into a 25-county study area that was further divided into three subregions. The counties that comprise the subregions and the combined lower Snake River study area are shown in Figure 1-1. The subregion models are applied in cases where impacts are localized. Examples of localized impacts include possible reductions in agriculture irrigated from Ice Harbor reservoir under Alternative 4, Dam Breaching. Changes in sportfishing and recreation trips to the lower Snake River are another example of localized impacts.

Models were also developed for the states of Washington, Idaho, Oregon, and Montana. These state models are used to assess impacts that would impact several states. State-level impacts assessed with these models are those associated with possible increases in electricity rates under Alternative 4, Dam Breaching.

In addition to potential project impacts that would occur in the lower Snake River region and possible increases in electricity rates that would likely affect a number of states, there would also be regional impacts associated with changed harvests of anadromous fish. These impacts were assessed for changes in both commercial and recreational harvests. This analysis conducted by the DREW Anadromous Fish Workgroup used input-output models constructed for the Pacific Northwest coastal counties.

The regional analysis is presented as Section 6.0 of this appendix.

1.3.4 Other Social Effects

The OSE account addresses potential effects from perspectives that are relevant to the evaluation process, but are not reflected in the other three accounts. Categories typically addressed as part of this account include community impacts; life, health, and safety factors; displacement; and long-term productivity. The social analysis presented in Section 7.0 of this appendix addresses some of the likely social impacts on selected local communities. The proposed alternatives would affect communities differently. One community may lose business and suffer an increase in unemployment and decreases in income and tax revenue, while other communities may benefit through increased investment or expenditures. The social analysis draws on the findings from the NED and RED analyses and primarily addresses 9 focus communities. These communities are highlighted on Figure 1-1.

Tribal communities are not addressed in the Social Analysis conducted by the Drawdown Regional Economic Workgroup (DREW) Social Analysis Workgroup, but are addressed separately in the Tribal Circumstances and Perspectives report developed by Meyer Resources, Inc., in association with CRITFC. The findings of this report are summarized in Section 5.0 of this appendix.

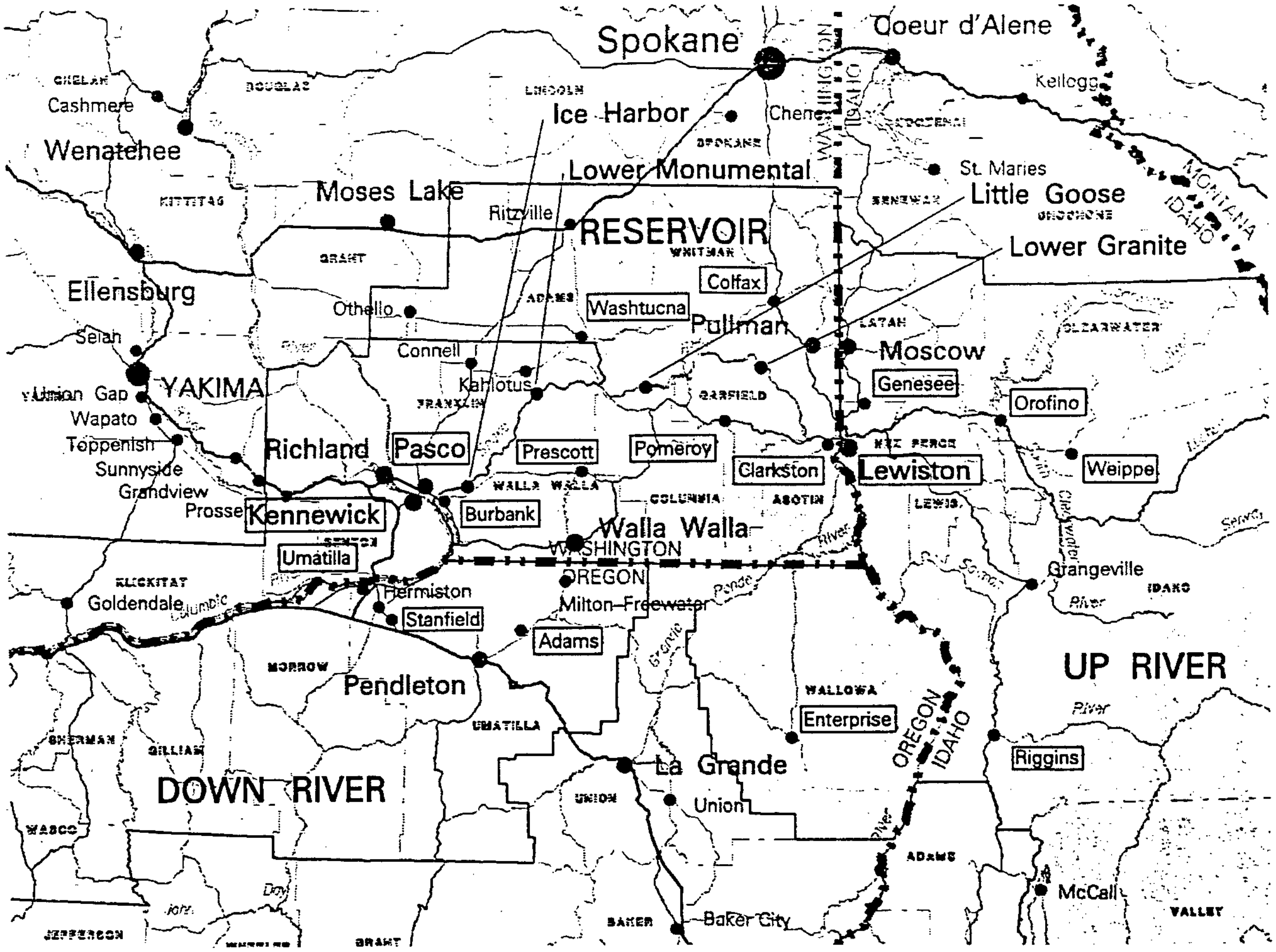

Figure 1-1. Subregions and Focus Communities

1.4 Drawdown Regional Economic Workgroup

The economic effects of actions related to the lower Snake River have been analyzed by numerous entities throughout the region. To reduce conflicting analyses and pool resources for a more efficient effort, the Corps convened the Drawdown Regional Economic Workgroup (DREW) to develop a combined economic analysis. Members of DREW include representatives of the Corps, Bonneville Power Administration (BPA), Bureau of Reclamation (BOR), National Marine Fisheries Service (NMFS), U.S. Environmental Protection Agency (EPA), U.S. Fish and Wildlife Service (USFWS), Northwest Power Planning Council (NPPC), CRITFC, and other interested groups. DREW meetings, held at various locations throughout the region on a roughly bi-monthly basis, were regularly advertised and open to the public. Members of the public regularly participated in and contributed to these meetings.

DREW conducted the necessary technical analyses to assess the economic impacts associated with each of the various alternatives. Within DREW, smaller workgroups oversaw and provided technical support for each area of analysis. The Technical Report on Hydropower Costs and Benefits was, for example, developed by the DREW Hydropower Impact Team. Study design and technical analysis was, as a result, a collaborative process that aimed to encompass a range of viewpoints and technical skills. Work products produced by DREW were reviewed by the NPPC's

Independent Economic Advisory Board (IEAB), a review board of economists drawn from academia and private industry. IEAB provided independent peer review of work products and advice in resolving technical issues, as necessary.

The key areas of analysis evaluated by DREW were closely related to one another. Results from one workgroup were often required inputs to another. Technical reports were developed for each area of analysis. The analysis presented in this appendix is based on the findings of these reports, which are referenced, as appropriate.

1.5 Study Assumptions

1.5.1 Period of Analysis and Price Level

DREW determined that a 100-year period of analysis would be used to assess all project impacts. This long-term perspective reduces the likelihood that the comparison of alternatives will be influenced by short-term fluctuations in trends or market conditions.

The base year for this analysis is fiscal year (FY) 1998, but the implementation year is FY 2005. FY 2005 was selected because it is assumed to be the earliest "in-service" date (assuming that the implementation process begins on January 1, 2001). The 100-year period of analysis extends from the implementation year, FY 2005, through 2104. Benefits and costs incurred during the period of analysis are discounted to the beginning of this period (FY 2005) using the selected interest rates (see below). Implementation expenditures and other economic costs and benefits that would occur prior to FY 2005 are brought forward to that date by charging compound interest at the project discount rate from the date that the costs and benefits occur. These costs and benefits are then converted into 1998 dollars and annualized to provide an average annual value for each alternative.

Due to the uncertainty associated with projecting socioeconomic parameters, projections of certain parameters, such as population, income, fuel prices, power loads, and commodities that would be transported on the lower Snake River are limited to a 20-year period from 1998 though 2018. From that point on, constant levels are assumed to the end of the 100-year period of analysis. These parameters are identified in the text, as appropriate.

1.5.2 Discount Rate

For most water-related projects, the bulk of project costs tend to be incurred during project implementation. Benefits, on the other hand, typically are realized as uneven flows of income or monetary benefits over a much longer time. Although both costs and benefits are measured in dollars, the dollars spent on implementation today cannot be directly compared to the dollars that will be realized years from now. One million dollars today, for example, is not the same as $1 million 20 years from now. The $1 million today could be put in the bank where it would earn 10 percent interest annually; in 20 years it would be worth $6.7 million. If, for example, a choice existed between building a $1 million project that would yield a $1 million benefit in 20 years or saving the money at 10 percent, clearly saving would be the best option from a purely economic perspective.

To account for differences in the time value of money, future benefits and costs of all components of the DREW analysis are discounted to a common date by using appropriate interest rates. This reduces the stream of benefits and costs that occur over the 100-year study period to a single value for each alternative. These present-worth values are then converted to an average annual values.

This practice is intended to allow reasonable cost comparisons among alternatives that have benefits and costs occurring at different times.

Selecting an appropriate discount rate for this type of economic analysis is often a source of controversy because it influences the attractiveness of allocating resources between the present and the future. Economic theory suggests that the discount rate used for project analysis should reflect the return that can be earned on resources employed in alternative private use. As a result, market interest rates tend to figure prominently in allocating investment funds among alternative uses. Market interest rates reflect the typical rates of real return on investments in the private economy and are instrumental in determining the values of real assets such as farmland, buildings, and equipment. However, if a notional "social rate of discount," which reflects widespread social attitudes on the importance of remote or postponed future flows of output and consumption, is lower than the market rate of interest, then an argument can be made for discounting future costs and benefits at that lower rate.

Numerous agencies and interests were involved in developing the economic analysis presented in this appendix. As a result, impacts are presented using three different discount rates: 6.875 percent—the rate used in economic analyses by the Corps, 4.75 percent—the rate customarily used by BPA, and 0 percent, which was included on behalf of the tribes represented by CRITFC. The Corps' discount rate is based on the cost of government borrowing. The BPA rate is intended to represent the "real" cost of borrowing money and does not include general inflation. The Corps' rate in contrast does include general inflation. The use of a 0 percent discount rate favored by the CRITFC tribes is based on a desire for permanence of certain assets like fish and wildlife. Benefits associated with projected fish recovery would occur over a long term rather than a short term. These benefits are valued more highly when using a 0 discount rate than the BPA rate of 4.75 percent or the Corps' rate of 6.875 percent. The appropriate use of discount rates has been the subject of some discussion within DREW and the IEAB. While three different discount rates have been used to accommodate a variety of perspectives, the use of these rates has little effect on the ranking of the alternatives.

1.5.3 Subsidies

The effects of subsidies are not addressed in all cases in the following analysis. Subsidies are primarily addressed in those cases where they are known and readily identifiable. This is particularly the case where components of the avoided cost analysis are subsidies. The costs to operate and maintain the navigation locks at the four lower Snake River dams, for example, are not directly transferred to users and are, therefore, considered by some to be subsidies. These costs are identified and presented as a savings or economic benefit in the Implementation and Avoided Costs analysis (Section 3.9). Possible subsidies to other groups, such as farmers, truck and rail services, and recreation users, were not researched as part of this study.

1.5.4 Uncertainty

Uncertainty is inherent in any future-oriented planning effort. The period of analysis for this economic study is 100 years. It is difficult to predict what will happen a few years into the future, let alone 100 years. Considerable uncertainty surrounds any attempt to forecast results 100 years into the future. In general, elements of uncertainty affect everything we do. The Corps' risk and uncertainty guidelines (Corps, 1992; 1995) state that, in the context of water resources planning,

"uncertainty is simply the lack of certainty. It is the reality of inadequate information. When information is imprecise or absent, that is uncertainty." From this perspective, uncertainty is present in all aspects of the Lower Snake River Juvenile Salmon Migration Feasibility Study. The plan formulation, the biology, and the economics all have elements of uncertainty in their analyses. Uncertainty of this type surrounds key study assumptions, methodology, and data collection in all resource areas.

The economic analysis presented in this appendix address the role of uncertainty in two ways. First, each study team was asked to address risk and uncertainty issues in their analyses. Second, an overall risk and uncertainty assessment of the economic and social analyses presented here was conducted as a separate part of the DREW process. The primary source of information for this risk and uncertainty assessment was information provided by the DREW study teams. The results of this assessment and the implications that risk and uncertainty have for the findings of this analysis are presented in Section 8.0 of this appendix.

2. Existing Conditions and Alternatives

This section provides an overview of existing conditions, and discusses the four alternatives considered as part of this feasibility study.

2.1 Existing Conditions

The following section presents summary information on existing conditions. Section 2.2.1 addresses existing socioeconomic conditions in the general project area. A more detailed overview of the existing socioeconomic environment is provided in Section 4.14 of the main FR/EIS text. Section 2.1.3 below provides summary conditions on the four lower Snake River dams and existing fish passage facilities. A more detailed description of these facilities and programs is presented in Chapter 2 of the main FR/EIS text.

2.1.1 Socioeconomic Overview

Land use in the plateau country of Oregon and Washington is predominantly agricultural and open space. Large farms are prevalent with population centers widely dispersed. The eastern portion of the study area, which extends into western Idaho, is largely rural with the primary industries being agriculture and forest products. Local economies in the immediate vicinity of the four lower Snake River dams are largely oriented toward the river system, which provides transportation for agricultural and timber products, water for farmland irrigation, and serves as a source of recreational activity.

Communities located in the vicinity of the lower Snake River would be affected by the natural river alternative. These effects would be felt primarily within communities in the immediate vicinity of the lower Snake River. Effects would also be felt in nearby upland areas that draw water supplies from the river and more distant commodity production areas that rely on the river for transportation. Alternative 4, Dam Breaching, also has the potential to generate indirect economic effects throughout the region. Potential sources of indirect regional economic effects include changes in navigation, recreational activities, commercial fisheries, and power. The regional and social impacts associated with the proposed alternatives are discussed in Sections 6 and 7 of this appendix, respectively. The following sections provide an overview of population and employment in the study region.

2.1.1.1 Population

The majority of the area surrounding the lower Snake River is sparsely populated. Communities range in size from small rural towns with populations less than 200 to cities with populations ranging from 8,000 to almost 50,000. Major population centers in the region include the Tri-Cities (Richland, Kennewick, and Pasco), Walla Walla, the Quad-Cities (Pullman, Moscow, Lewiston, and Clarkston), and Hermiston/Pendleton. Only five communities in the general study area have populations greater than 20,000.

Most of the region experienced fairly rapid rates of population growth in the 1970s. Growth rates were significantly slower in the 1980s with a number of counties experiencing absolute decreases in population. Population has grown more rapidly in the 1990s, with areas offering high quality scenery and recreation opportunities often experiencing particularly rapid growth rates.

Summary population data are presented in Table 2-1 for the states of Washington, Oregon, and Idaho, as well as the three subregions that comprise the 25-county study area identified by the DREW Regional Workgroup (see Figure 1-1 and Section 6).

Table 2-1. Population by State and Subregion, 1970-95

	Total Population				Percent Change		
	1970	**1980**	**1990**	**1995**	**1970-80**	**1980-90**	**1990-95**
Washington	3,413,244	4,132,353	4,866,692	5,430,940	21.1	17.8	11.6
Oregon	2,091,533	2,633,156	2,842,337	3,140,585	25.9	7.9	10.5
Idaho	713,015	944,127	1,006,734	1,163,261	32.4	6.6	15.5
Subregions							
Downriver	172,712	241,361	246,560	278,429	39.7	2.2	12.9
Reservoir	139,055	159,178	162,167	178,739	14.5	1.9	10.2
Upriver	101,292	114,968	114,212	124,951	13.5	-0.7	9.4
Total Study Area	**413,059**	**515,507**	**522,939**	**582,119**	**24.8**	**1.4**	**11.3**

Source: U.S. Census Bureau, 1970, 1980, 1990; State Estimated, 1995

2.1.1.2 Employment

The economy of the Pacific Northwest has undergone substantial change over the past three decades. From 1970 to 1995, the number of jobs in the Pacific Northwest grew at a faster rate than the nation as a whole. The nation saw a 64 percent increase in the absolute number of jobs while employment in the states of Washington, Oregon, and Idaho more than doubled over the same time period. The total number of jobs in both the region and the study area has increased even as employment in historically important job sectors, such as manufacturing, logging, mining, and farming and ranching has declined or remained stagnant. This is also the case with the 25-county lower Snake River study area.

Employment in the study area increased in nearly all sectors between 1970 and 1995 (Table 2-2). Exceptions include the farm and military sectors, both of which experienced an absolute decline in the numbers employed. Employment in service industries has increased significantly. Service industry increases include gains in recreation and tourism, business, education, and management and engineering services. The study area also experienced large gains in the retail trade and state and local government sectors. Growth was also evident in the wholesale trade and the finance, insurance, and real estate sectors.

The majority of towns in the lower Snake River study area are small. Small towns typically have relatively narrow economic bases with fewer industries and fewer firms per industry than larger communities. Almost half of the communities in the region have 20 percent or more of their employment in agriculture, while 68 percent of the communities have 11 percent or more employment in the agricultural sector. This employment includes not only farm proprietors and employees but also farm services. The two other dominant sectors present in the region are state and local government, including school employees, and travel and tourism.

Table 2-2. Employment in the Lower Snake River Study Area, 1970-95

	1970		1995		Change 1970-95	
		%		%		%
Total full- and part-time employment	183,686		318,740		135,054	73.5
Farm employment	29,417	16.0	27,625	8.7	-1,792	-6.01
Nonfarm employment	154,269	84.0	291,115	91.3	136,846	88.7
Ag. serv., forestry, fishing, and other	1,894	1.2	7,721	2.7	5,827	308
Mining	430	0.3	738	0.3	308	71.6
Construction	8,238	5.4	14,715	5.1	6,477	78.6
Manufacturing	24,343	15.9	30,955	10.8	6,612	27.2
Transportation and public utilities	7,745	5.0	11,726	4.1	3,981	51.4
Wholesale trade	4,580	3.0	10,540	3.7	5,960	130
Retail trade	26,732	17.4	53,079	18.6	26,347	98.6
Finance, insurance, and real estate	8,184	5.3	13,290	4.6	5,106	62.4
Services	32,948	21.5	83,390	29.2	50,442	153
Government and government	38,376	25.0	59,740	20.9	21,364	55.7

Source: U.S. Bureau of Economic Analysis, 1999

2.1.2 Authorized Project Purposes

Authorized project uses include power, navigation, recreation, and irrigation. The following sections provide a brief overview of each of these resources. These resources are discussed in more detail in Chapter 4 of the main EIS/FR and Section 3 of this appendix. Fish and wildlife is also an authorized use at all four dams. Fish and wildlife measures are addressed in Section 2.1.3 below.

2.1.2.1 Power

The integrated system of 30 Federal hydroelectric facilities in the Columbia River Basin, on average, accounts for approximately 60 percent of total regional energy and 70 percent of total electrical generating capacity. The four lower Snake River dams account for approximately 12 percent of hydropower sustained peak capacity in the Pacific Northwest and 8 percent of the region's total sustained peak capacity.

When there is a surplus of hydropower, it is an important export product for the region. BPA markets and distributes the power generated by the Corps and the Bureau of Reclamation at the Federal projects in the Columbia River Basin, including power generated by the four dams on the lower Snake River. This power is sold to public and private utilities in the region, utilities outside the region, and some of the region's largest industries. Power lines originate at generators at the dams and extend outward to form key links in the regional transmission grid. The Northwest grid is interconnected with Canada to the north, California to the south, and Utah and other states to the east. Power produced at dams in the Northwest serves customers both locally and thousands of miles away.

2.1.2.2 Navigation

The 465-mile-long Columbia-Snake Inland Waterway formed by the eight dams and locks on the lower Columbia and Snake rivers allows barge transportation from the Pacific Ocean to Lewiston, Idaho, the most inland port. This system is used for commodity shipments from inland areas of the Northwest and as far away as North Dakota. The 140-mile-long stretch of the waterway formed by the four lower Snake River dams extends from the confluence of the lower Snake and Columbia rivers to Lewiston, Idaho. The Corps maintains a navigation channel 250 feet wide and 14 feet deep along this portion of the waterway. This navigation channel accommodates tugs, numerous types of barges, log rafts, and recreational boats and connects the interior Columbia River Basin with deep water ports on the lower Columbia River.

Tonnage using at least a portion of the lower Snake River averaged about 3.8 million tons per year from 1980 through 1990. This average increased slightly to 3.9 million tons per year from 1991 through 1996. Grain shipments made up approximately 75 percent of this tonnage in 1995.

2.1.2.3 Recreation

There are 33 developed recreation sites adjacent to the lower Snake River reservoirs. Facilities at these sites include 28 boat ramps with 59 launch lanes, 5 moorage and marina facilities, 9 campgrounds with approximately 422 individual campsites, and 49 day-use facilities. Most of these sites are located in rural areas removed from population centers. Exceptions include the sites located at Ice Harbor Reservoir, which are close enough to be used by residents of the Tri-Cities, and sites located at Lower Granite Reservoir near the Lewiston-Clarkston area. Several of the larger developed sites were developed by the Corps and are operated by counties or port districts under lease.

Primary recreational activities, including sightseeing, fishing, boating, and water-skiing, occur year-round at most dams and reservoirs in the Columbia River Basin. However, the peak periods of use for all activities occur during the warm, dry summer months. The lower Snake River dams and reservoirs typically receive over 50 percent of average annual reservation from May through August. Approximately 2 million visitor days were recorded at the four dams and reservoirs in 1998. Many of these visitors live in relatively close proximity to the dams and reservoirs.

2.1.2.4 Irrigation

Water is withdrawn from the lower Snake River to support many uses. Irrigated agriculture is the dominant use, followed by municipal and industrial (M&I) water supply, wildlife habitat enhancement, and cattle watering. Nearly all of the lower Snake River water used for agricultural irrigation is withdrawn from the Ice Harbor Reservoir. Private entities have developed the necessary infrastructure to grow irrigated crops adjacent to the reservoir. Approximately 37,000 acres of agricultural land are presently irrigated using water withdrawn from Ice Harbor Reservoir. Cottonwood, which is grown for pulp and paper production, is the largest crop in terms of acreage, accounting for approximately 27 percent of total crop acreage irrigated with water withdrawn from Ice Harbor Reservoir in 1996/1997.

There are eight M&I pump stations along the lower Snake River, all located on Lower Granite Reservoir. Water withdrawn via these stations is used for municipal water system backup, golf course irrigation, industrial process water, and park irrigation. Water withdrawn from the lower Snake River presently irrigates vegetation for ten wildlife Habitat Management Units (HMUs) that

were established to compensate for wildlife habitat lost as a result of inundation by the lower Snake River dams. Cattle watering corridors provide access across government property for cattle to water from the lower Snake River reservoirs.

2.1.3 Facilities and Programs

The four lower Snake River dams—Lower Granite, Little Goose. Lower Monumental. and Ice Harbor—are multi-purpose facilities that provide public benefits in many different areas. The purposes authorized by Congress for the Lower Snake River Project are navigation. hydropower. irrigation, recreation, and fish and wildlife. Project facilities include dams and reservoirs. hydroelectric powerplants and high-voltage transmission lines, navigation channels and locks. juvenile and adult fish passage structures, parks and recreational facilities, lands dedicated to project operations, and areas set aside as wildlife habitat.

All four lower Snake River dams are run-of-river facilities. These dams have limited storage capacity and pass water at nearly the same rate as the water enters each reservoir. Reservoir levels behind these dams vary only a few feet during normal operations. This limited storage is used for hourly regulation of powerhouse discharges to follow daily and weekly demand patterns. This storage is not enough to allow seasonal regulation of streamflows. Other Federal dams on the Columbia River and its tributaries were developed for storage purposes. Storage reservoirs, such as the Dworshak Reservoir on the North Fork of the Clearwater River, are used to store water and adjust the river's natural flow patterns to conform more closely with water uses.

The normal operating ranges and usable storage volumes for the affected hydropower facilities are listed in Table 2-3. While it is physically possible to draw run-of-river reservoirs well below their normal minimum pool levels, the four lower Snake River facilities are not designed to operate below minimum pool levels.

Table 2-3. Characteristics of the Four Lower Snake River Facilities

Facility	Snake River Mile	Facility Ownership	Reservoir Name	Reservoir Capacity (normal operating range, acre-feet)	Reservoir Elevation (normal operating range, msl)
Lower Granite	107.5	Corps	Lower Granite Lake	49,000	733 to 738
Little Goose	70.3	Corps	Lake Bryan	49,000	633 to 638
Lower Monumental	41.6	Corps	Lake Herbert G. West	20,000	537 to 540
Ice Harbor	9.7	Corps	Lake Sacajawea	25,000	437 to 440

msl = mean sea level

2.1.3.1 Adult and Juvenile Fish Facilities

Adult fish passage systems are provided at each of the four dams and include fish ladders, pumped attraction water supplies, and powerhouse fish collection systems. Adult fish passage facilities are operated in accordance with the Corps' Fish Passage Plan (Corps, 1999) as prescribed in the 1995

Biological Opinion and the 1998 Biological Opinion. The operation period is typically from March 1 through December of each year. Juvenile fish bypass facilities were installed at each of the four lower Snake River dams shortly after they were constructed. Current measures for collection and transportation of juvenile fish outmigration are identified in the 1995 Biological Opinion, 1998 Biological Opinion, and the Endangered Species Act (ESA) Section 10 Permit (#895) for the Juvenile Fish Transportation Program (JFTP). The Corps operates the JFTP in cooperation with NMFS and in accordance with the 1995 Biological Opinion and 1998 Biological Opinion.

Juvenile fish are transported under the guidelines of the Fish Passage Plan and the Corps' JFTP. Juvenile fish are not transported at Ice Harbor Dam, but the majority are bypassed directly to the tailrace below the dam. At Lower Granite, Little Goose, and Lower Monumental dams, juvenile fish that go through the bypass systems can be routed either directly back into the river below the dam, or to holding and loading facilities for loading into barges or trucks for transport. Trucks are used for transport when the number of fish collected is 20,000 or fewer per day at Lower Granite.

The transport barges and trucks carry the fish past the remaining projects for release below Bonneville Dam. River water circulates through the barges, allowing the fish to imprint the chemicals and smells of the water during the trip downriver. The adults use this "imprinting" mechanism during upstream migration to guide them to the location where they originated (e.g., spawning area or hatchery).

Collection of juvenile fish generally starts March 25 at Lower Granite Dam and a few days later at Little Goose and Lower Monumental dams. Eight barges are used. Early in the season (typically the second week in April), a barge leaves Lower Granite every other day. As numbers of fish increase, barging is increased to every day. In order to follow the "spread-the-risk" policy described in the 1995 and 1998 Biological Opinions, the current goal is to transport about half of the juvenile Snake River salmon and steelhead. The remainder are either bypassed back to the river, pass through the turbines, or may pass over the spillway if spill occurs.

The Lower Snake River Project facilities are run-of-river and provide little storage of water. Therefore, when reservoirs are full and flows exceed the capacity of the powerhouse or power output needs, water is involuntarily spilled. In contrast, voluntary spills would be those that are not required to pass excess flows downstream (e.g., the powerhouse could pass the flows and there is sufficient power demand). Voluntarily passing water over dam spillways rather than through the powerhouse is an operations approach used to divert juvenile fish from the turbines as they approach a dam.

Dams upstream of Lower Granite can regulate water for flood control, irrigation, and other uses, interrupting the seasonal river flow patterns in downstream areas. Flow augmentation (i.e., increasing river flows above levels that would occur under normal operation by releasing more water from storage reservoirs) can aid migration of juvenile salmon.

In the 1993 and 1995 Biological Opinions, NMFS requested the use of an additional 427,000 acre-feet from upstream storage in Idaho for flow augmentation. This is provided by BOR from the Snake River Basin upstream from Brownlee Dam. Water is secured from BOR's uncontracted reservoir space, water rentals, and by permanent acquisition of reservoir storage space and natural flow rights. The Idaho statute that authorized release of the additional 427,000 acre-feet will expire on January 1, 2000.

The 1995 Biological Opinion discusses the need to pursue the acquisition of additional water after 1998 if necessary to contribute to the survival and recovery of listed fish species. The 1998 Biological Opinion did not change this need. The 1998 Biological Opinion did, however, request that studies be conducted to evaluate an increase in flow above the 1995 amount, perhaps by another one million acre-feet. BOR has conducted the study of the effects of providing one million acre-feet, but no actions have been authorized or implemented.

2.1.3.2 Lower Snake River Fish and Wildlife Compensation Plan

The Lower Snake River Fish and Wildlife Compensation Plan (LSRFWCP) was authorized by the Water Resources Development Act of 1976 to mitigate for fish and wildlife losses caused by construction and operation of the four lower Snake River dams. The LSRFWCP consists of fish hatcheries, satellite fish facilities, a fish laboratory, wildlife habitat areas and development areas, and lands with fishing and hunting access. The facilities and lands of the LSRFWCP are primarily located in the upper, middle, and lower subbasins of the Snake River Drainage, in the states of Washington, Oregon, and Idaho. The remaining facilities and lands are located in the upper Columbia, Yakima, and Mid-Columbia subbasins. Some development is located on existing Federal lands, but the majority is on additionally-acquired lands and easements.

Eleven fish hatcheries were modified or constructed under this plan, along with a number of collection facilities for gathering adults and acclimation ponds for acclimating juveniles to water sources where they would return as adults. These facilities are operated by the state fisheries agencies or the USFWS. Additional recently constructed acclimation facilities are operated by the Nez Perce Tribe and the Confederated Tribes of the Umatilla Indian Reservation. In addition, the listing of the sockeye salmon resulted in a captive broodstock program that is funded by the BPA. Also, the Nez Perce Tribe has been transporting coho salmon from the lower Columbia River to the Clearwater Basin in an attempt to re-establish runs of these species.

The LSRFWCP also includes 62 HMUs that were developed as mitigation for the loss of habitat associated with the four dams and reservoirs. These HMUs, developed for a wide variety of habitat and species, range in size from less than 1 acre to over 3,000 acres.

2.2 Alternatives Considered

In response to NMFS' 1995 Biological Opinion and the results of the Interim Status Report (Corps 1996), the Corps continued its ongoing process of evaluating various system improvements. These measures are intended to improve the effectiveness of downstream migration by juvenile salmonids and upstream passage of adults. This appendix is a part of the Feasibility Report that analyzes a range of possible actions on the lower Snake River. Other aspects of the Columbia River and upper Snake River operations are addressed under related study processes. These include investigations into drawdown of the reservoir at the John Day Project and studies associated with the Federal relicensing of Idaho Power's Hells Canyon Dam Complex on the Snake River.

The lower Snake River Feasibility Study has been underway since 1995 and numerous alternatives have been identified and assigned combinations of numbers and letters to serve as unique identifiers. However, different study groups involved in the process have all used slightly different numbering or lettering schemes over the last 3 years. The primary alternatives that are being carried forward in this Feasibility Study currently involve four major concepts derived from three major pathways.

The four alternatives that are being evaluated in detail are presented in Table 2-4 along with the naming conventions that have been used by various study groups involved in the study.

Table 2-4. Current Study Alternatives Naming Conventions

Pathway Name	Alternative Name	PATH Number	Corps Number
Existing System	Existing Conditions	A-1	A-1
Major System Improvements	Maximize Transport	A-2	A-2a
Major System Improvements	Major System Improvements	A-2'	A-2c
Natural River Drawdown	Dam Breaching	A-3	A-3a

2.2.1 Existing Conditions

The Existing Conditions alternative consists of continuing the fish passage facilities and project operations that were in place or under development at the time that this Feasibility Study was initiated. The existing programs and plans underway would be continued to meet the authorized purposes of the Lower Snake River Project. Project operations including all ancillary facilities such as fish hatcheries and Habitat Management Units (HMUs) under the Lower Snake River Fish and Wildlife Compensation Plan (LSRFWCP), recreation facilities, power generation, and irrigation would remain the same, unless modified through future actions. Adult and juvenile fish passage facilities would continue to operate. Similarly, work on prototype testing of surface bypass collectors (SBC) at Lower Granite would continue. The Existing Conditions alternative also includes several other planned measures that would affect fish-related expenses. These include:

- New turbine cams that control the turbine blades and wicket gates.
- New turbine runners that may reduce fish stress and mortality.
- Upgrades to Lower Granite Juvenile Fish Facilities.
- Up to seven new fish barges to replace two barges scheduled for retirement.
- Adult fish attraction modifications at fish ladders to ensure adequate water supply is maintained in the event of a pump failure.
- Trash shear boom at Little Goose to capture more debris before it gets into the juvenile fish facilities.
- Modified fish separators to improve fish separation and to reduce stress, delay, and mortality at existing juvenile fish facilities.
- Cylindrical dewatering screens to reduce the amount of water needed for fish collection facilities at Little Goose, Lower Monumental, and Ice Harbor.
- Spillway deflectors/pier extensions at Lower Granite, Little Goose and Lower Monumental to further reduce dissolved gas concentrations.

2.2.2 Maximize Transport

The Maximize Transport alternative would include all of the existing or planned structural and operational configurations from the existing conditions alternative. However, this alternative assumes that the juvenile fishway systems would be operated to maximize fish transport and that voluntary spill would not be used to bypass fish through the spillways (except at Ice Harbor). To accommodate this transport, some measures would be taken to upgrade and improve fish handling facilities.

2.2.3 Major System Improvements

The Major System Improvements alternative would provide additional improvements to those considered under the existing conditions alternative. These improvements would be focused on using SBC facilities in conjunction with extended submerged bar screens (ESBS) and a behavioral guidance system (BGS) located in the turbine intakes. The intent of these facilities is to provide more effective diversion of juvenile fish away from the turbines. Under this alternative the number of fish collected and delivered to upgraded transportation facilities would be maximized as in the maximize transport alternative. A variety of options under this alternative could be implemented, depending upon results of ongoing or future tests of equipment, facilities, and approaches.

2.2.4 Dam Breaching

The Dam Breaching alternative is also called the drawdown alternative in many of the Feasibility Study reports. The term Drawdown, as used by many study groups since late 1996, represents the same alternative as Dam Breaching. There are, however, many types of possible drawdown activities. Therefore, the term dam breaching was created to describe the action behind the alternative. The reservoirs would be evacuated or drawn down by the act of breaching. The dam breaching alternative would involve significant structural modifications at the four lower Snake River dams allowing the reservoirs to be drained resulting in a free-flowing river that would remain unimpounded. Dam breaching would involve removing the earthen embankment sections of the four dams and then developing a channel around the powerhouses, spillways, and navigation locks. With dam breaching, the navigation locks would no longer be operational, and navigation for larger vessels would be curtailed. Some recreation facilities would close while others would be modified and new facilities could be built in the future. The operation and maintenance of hatcheries and HMUs would also change although the extent of change would probably be small and is not known at this time. Dam breaching activities would take at least two full years to complete after an estimated five year period necessary for preparation of a detailed design report and preparation of contracts. Structural modifications would include:

- Modifying intake gates and bulkheads at generator intake bays;
- Removal of generation equipment and dewatering draft tubes and drains;
- Modifications to the powerhouse outlets;
- Placement of sheetpiling or rock materials to stabilize the tailraces;
- Excavation of a river channel around the dam structures with new levee construction;
- Removal of embankment structures;

- Stabilization of highway and railroad bridges and embankments;
- Modification of the water siphons at the Lewiston levees and the adult fish ladder at Lyons Ferry Hatchery;
- Relocation of roads, railroads, and other facilities at the new channel locations;
- Extension of boat ramps and other facility modifications for water wells and other water dependent features.

Other alternatives have been considered by study groups including alternatives that would change upper Snake River flow augmentation levels. These alternative analyses are not presented here as flow augmentation changes are not being carried forward in this study at this time. However, several reports have been completed that evaluated flow augmentation changes and these include the Bureau of Reclamation's Snake River Flow Augmentation Impact Analysis report published in February 1999 (see report on the Corps' website).

3. National Economic Development Analysis

3.1 Power System Impacts

3.1.1 Introduction

The section summarizes the findings in the Technical Report on Hydropower Costs and Benefits prepared by the Drawdown Regional Economic Workgroup Hydropower Impact Team (DREW Hydropower Impact Team, 1999). The purpose of this hydropower analysis was to identify the net economic costs associated with changes in hydropower production at the four lower Snake River facilities.

The scope of the hydropower impacts is large. Columbia River Basin hydropower projects serve as a major element in the Pacific Northwest electrical industry, and provide about 60 percent of the total regional energy needs and 70 percent of the total electrical generating capacity in the region on an average basis. The nature of hydropower is that it is available in different amounts from year to year depending on streamflow conditions. In wet years, the amount of hydropower generation can be significantly greater than the average conditions, and this energy (commonly referred to as secondary) can serve as a major part of the export market outside of the Pacific Northwest. In low water years, or high demand periods within a year, energy is often imported into the Pacific Northwest to meet the power demands. Consequently, any changes in the generation of Pacific Northwest hydropower could impact the amount of energy bought and sold, and the number of new generating facilities to be built, throughout the entire West Coast of the United States. For these reasons, the scope of this analysis is the entire western United States and parts of Canada as defined by the Western Systems Coordinating Council (WSCC). The WSCC is a one of nine regional energy reliability councils that were formed due to a national concern regarding the reliability of interconnected bulk power systems. The WSCC comprises all or part of the 14 Western States and British Columbia, Canada, over 1.8 million square miles.

The hydropower study was conducted jointly by staffs of the Corps and the regional power marketing agency, Bonneville Power Administration (BPA). As with other economic impact areas, an oversight group was formed to assist in the analysis and to provide a forum for interested parties to provide input. The Hydropower Impact Team (HIT) consisted of 10 to 20 members from numerous interested entities such as the Northwest Power Planning Council, the Bureau of Reclamation, National Marine Fisheries, regional tribes, river interest groups, and environmental groups. The HIT met regularly during the study to discuss appropriate approaches and assumptions to use in the analysis. The HIT also provided review and comments on drafts of the hydropower technical report.

The study process incorporated several elements to arrive at the estimate of economic effects associated with changes in hydropower with each of the alternatives. The process first considered how the impacted hydropower facilities currently function, and used system hydroregulation studies to estimate how much hydropower generation will occur with the different alternatives and different water conditions. This information was then incorporated into power system models to estimate how changes in hydropower generation will affect generation from other more costly power resources. Estimates of future market-clearing prices were also examined. The market price analysis examined economic effects by pricing the loss of hydropower generation based on the estimated future market prices for the base condition. A wide range of key study assumptions was investigated and the uncertainties associated with these assumptions were examined. Sensitivity tests were performed on

some of the major study assumptions to assure that results were reasonable from a wide range of viewpoints. The financial impact on regional ratepayers and possible mitigation for these impacts were also investigated. The power system modeling tools were used to help identify the changes in air pollutant emissions with the different alternatives.

3.1.2 Hydropower Characteristics

The hydropower facilities of most interest to this study were the four lower Snake River facilities of Ice Harbor, Lower Monumental, Little Goose, and Lower Granite. However, almost all the hydropower projects in the Columbia-Snake system will be impacted under at least one of the alternatives being investigated. Table 3.1-1 describes some of the hydropower characteristics of each lower Snake River hydropower facility. Three of the lower Snake River facilities are essentially identical in terms of hydropower facilities. The Ice Harbor facility was constructed several years before the others and has less capacity. The overload capacity represents the maximum output that can be achieved. The average annual energy is presented in two different units: the average MW (aMW) which is the amount of generation averaged over all the hours of the year (8,760 hours), and the annual MWh which is the sum of all generation over the entire year. This energy data was taken from the average of 60 historic water years for the base condition.

Table 3.1-1. Hydropower Plant Characteristics

	Ice Harbor	Lower Monumental	Little Goose	Lower Granite	Lower Snake Totals
Number of Units	6.0	6.0	6.0	6.0	24.0
In-Service Date	1 (1961) 2 (1962) 3 (1975)	2 (1969) 1 (1970) 3 (1979)	3 (1970) 3 (1978)	3 (1975) 3 (1978)	
Energy:					
Average Annual Energy (aMW) for Base Condition	264	332	317	333	1,246
Average Annual Energy (1,000 MWh) for Base Condition	2,313	2,908	2,777	2,917	10,915
Plant Factor Base Condition (%)	38	36	34	36	36
System Energy Comparisons:					
Percent of Pacific Northwest Federal System Avg Energy (Fed System = 11,136 aMW) (%)	2	3	3	3	11
Percent of Total Pacific Northwest System Avg Energy (System = 24,479 aMW) (%)	1	1	1	1	5
Capacity:					
Nameplate Capacity Per Unit (MW)	3 (90) 3 (111)	135	135	135	
Total Nameplate Capacity (MW)	603	810	810	810	3,033
Overload Capacity (Total Maximum Output) (MW)	693	931	931	931	3,486
System Capacity Comparisons:					
Percent of Pacific Northwest Federal System Peaking Capacity (Fed System – 23,824 MW) (%)	3	4	4	4	15
Percent of Total Pacific Northwest System Peaking Capacity (System = 47,859 MW) (%)	1	2	2	2	7

Figure 3.1-1 shows an estimate of the average monthly generation of the four lower Snake River plants by month based on a system hydroregulation model for the base condition (Alternative 1, Existing Conditions). The amount of generation from these plants can change significantly in different water years (WY) and seasons. The figure compares the monthly generation for a 60-year average simulation (from year 1929 to 1988), a low water year (1930-31), and a high water year (1955-56).

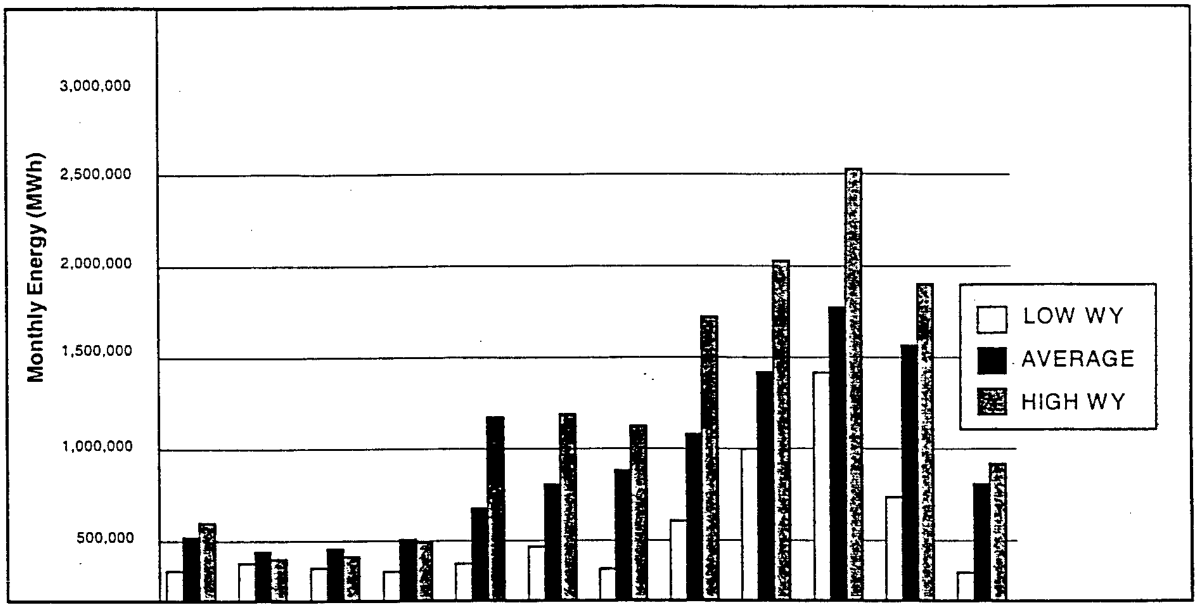

Figure 3.1-1. Alternative 1, Existing Conditions Results - Monthly Generation - 4 Snake River Dams Low WY (1930), High WY (1955-56) & 60 Year Average

Figure 3.1-2 presents the monthly generation-duration curve based on the 60 water year conditions from 1928 to 1988, for the base condition. The generation in this figure is the combined monthly generation of the four lower Snake River facilities. This figure shows the percent of time in which average monthly generation equals or exceeds the generation in MW. For example, the monthly generation equals or exceeds 1,000 MW about 50 percent of the months of the 60 water years, and equals or exceeds 2000 MW about 20 percent of the time.

The hourly operation of the lower Snake River plants is determined primarily by the amount of Snake River water arriving at Lower Granite because the four reservoirs have very limited storage capability and only minor tributary inflows into the other reservoirs. The ability to store water over the week, month, or season cannot occur at these facilities. The facilities can somewhat shape the amount of generation throughout the day with the limited storage within the top 3 to 5 feet of operating range over the juvenile fish non-migrating periods of November through March.

3.1.3 Power System Characteristics

Table 3.1-2 demonstrates to what extent each power-generating source is used in the Pacific Northwest. As can be seen in the table, hydropower makes up about 67 percent of the Pacific Northwest's total generating capacity, followed by coal. Next in terms of capacity available to meet demand is the import over the intertie system from regions outside of the Pacific Northwest. The

firm energy amount shown in this table reflects that which can be generated in the low water year of 1936-37. The year 1937 has been defined as the critical year for defining firm energy in many regional power planning studies.

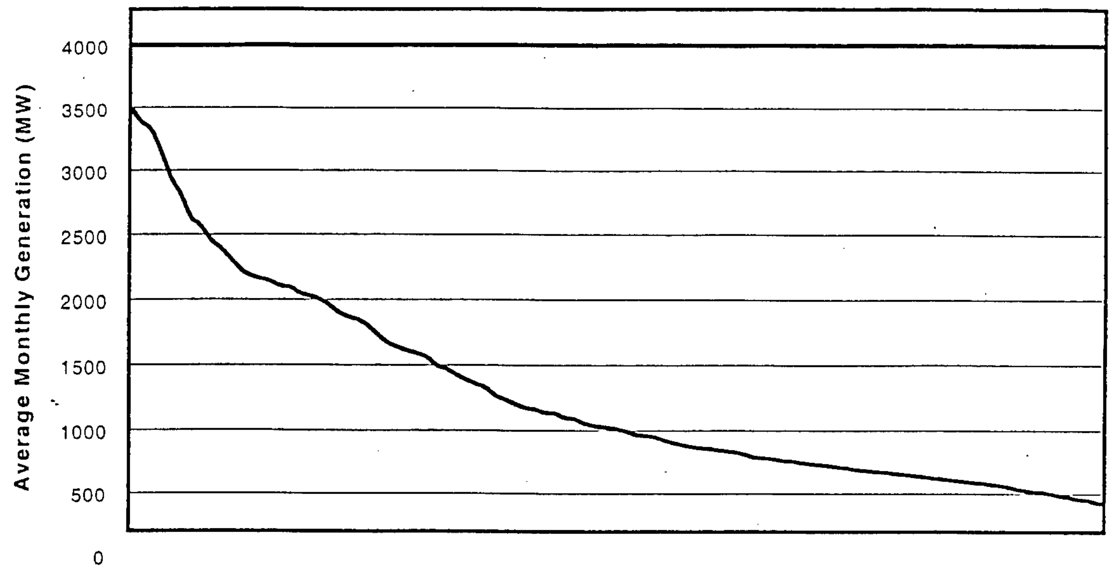

Figure 3.1-2. Lower Snake River Plants - Monthly Generation Duration

Table 3.1-2. The Pacific Northwest Electric Generating Resources 1997[1/]

Resource Type	Sustained Peak Capacity[2/] (MW)	% of Total Capacity	Firm Energy[2/] (aMW)	% of Firm Energy
Hydro	25.887	67	12,187	57
Coal	4,521	12	4.061	19
Nuclear	1,162	3	841	4
Imports	2,996	8	1,669	8
Combustion Turbines	1,665	4	753	4
Non-utility Generation	1,166	3	1,051	5
Cogeneration	775	2	675	3
Other	264	1	171	1
TOTAL	38.436	100	21,408	100

1/ Source: BPA's *1997 FAST FACTS*
2/ For more information see BPA's *Pacific Northwest Loads & Resources Study*

A distinction is often made between firm (also referred to as primary) energy and non-firm (referred to as secondary) energy in power markets because the firm energy can be counted on even in the most extreme historical low water years.

Table 3.1-3 provides generation and capacity information for the entire WSCC, based on actual generation in 1997, rather than the firm energy. The most prominent source of generating capacity

and energy in the WSCC is hydropower, but to a significantly less extent than in the Pacific Northwest. Coal and natural gas driven thermal plants provide a much larger share of capacity and energy in the WSCC than in the Pacific Northwest. However, hydropower makes up the vast majority of system capacity and generation in the Pacific Northwest, and is the largest contributor for the entire WSCC.

Table 3.1-3. Western Systems Coordinating Council (WSCC) Electric Generating Resources, 1997

Resource Type	Capacity (MW)	% of Total Capacity	1997 Energy (aMW)	% of Total Energy
Hydro-Conventional	61,043	39	33,367	39
Hydro-Pump Storage	4,316	3	533	1
Steam – Coal	36,325	23	28,378	33
Steam – Oil	746	<1	239	<1
Steam – Gas	23,241	15	5,018	6
Nuclear	9,258	6	7,472	9
Combustion Turbine	5,846	4	206	<1
Combined Cycle	3,777	2	779	1
Geothermal	3,060	2	2,270	3
Internal Combustion	293	<1	-	<1
Cogeneration	8,119	5	5,954	7
Other	1,891	1	1,317	2
Pump-Storage Pumping			(445)	-1
Total	157,915	100	85,089	100

Source: 1998 WSCC Information Summary

3.1.4 Hydroregulation Models

The first step in defining the power impacts was to identify the amount of hydropower generation with each alternative. The second step was to identify the economic effects of changes in the hydropower.

The study utilized two system hydroregulation models to perform the first step. The system hydroregulation models simulate the operation of hydropower plants with each alternative with historical water conditions encountered over 50 or 60 water years, depending on which model is used. The models were used to define the power impacts at each hydropower plant in the Pacific Northwest with the alternative operations of the system. The model used by the Corps was the Hydro System Seasonal Regulation Program (HYSSR) and the BPA model was the Hydro Simulator Program (HYDROSIM). The major output of either model was a month-by-month hydropower generation amount from each hydropower plant in the Columbia Basin, for each of the years simulated by the models. See Appendix G, Hydroregulations, of the Feasibility Report for a detailed description of the hydroregulation models.

Table 3.1-4 summarizes the total monthly Pacific Northwest system generation amounts for each of the alternatives as compared to the base case condition, Alternative 1, Existing Conditions. This table provides the monthly averages over all the water year simulations done by the HYSSR (60 years) and HYDROSIM (50 years). The table shows the total hydropower production in the Pacific Northwest (System Generation). The HYSSR and HYDROSIM models have slightly different

definitions of which hydropower facilities are included in the Pacific Northwest system generation, and hence the total system generation amounts are slightly different. These differences in system-wide hydropower generation estimates are used later in this analysis to define the economic effects of each alternative. Sections 1 and 3 of Table 3.1-4 show the average system generation for each alternative from the HYSSR and HYDROSIM models. However, the most important element of this study is the change in generation from the base condition. Sections 2 and 4 show the change in generation from the base condition (Alternative 1, Existing Conditions) with each alternative. The last section in the table presents the differences in net generation as defined by the two hydroregulation models. The differences in two models' estimation of change in generation with each alternative are relatively small, on average, but can be significant for specific months and alternatives.

Table 3.1-4. Hydropower Analysis: HYSSR and HYDROSIM Results by Alternative—System Generation (aMW)

HYSSR Results: Average Generation Over 60 Water-Year Simulations

Alternatives	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	ANN. AVG.
1	9,466	9,520	10,414	14,071	16,800	15,200	13,820	15,846	18,729	18,834	13,725	11,997	14,038
2 and 3	9,467	9,533	10,418	14,078	16,803	15,203	13,820	16,006	19,049	19,139	13,743	12,008	14,108
4	9,046	8,953	10,021	12,867	15,987	14,098	11,794	13,437	16,314	16,703	12,728	11,280	12,771

System Impacts HYSSR
(Generation Difference From A1; Negative Means Loss In Energy From Alternative 1)

Alternatives	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	ANN. AVG.	% OF ALT.1
2 and 3	1	13	4	7	3	3	0	160	320	305	18	11	70	0.5
4	(420)	(567)	(393)	(1,204)	(813)	(1,102)	(2,026)	(2,409)	(2,415)	(2,131)	(997)	(717)	(1,267)	(9.0)

HYDROSIM Results: Average Generation Over 50 Water-Year Simulations

Alternatives	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	ANN. AVG.
1	10,572	11,558	12,735	15,935	19,669	16,435	14,858	17,777	20,487	19,960	15,333	13,108	15,702
2 and 3	10,572	11,558	12,735	15,935	19,671	16,435	14,858	17,927	20,732	20,202	15,343	13,108	15,756
4	10,183	10,865	12,244	15,031	18,677	15,324	13,057	15,676	18,168	17,923	14,220	12,352	14,477

System Impacts HYDROSIM
(Generation Difference From A1; Negative Means Loss In Energy From Alternative 1)

Alternatives	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	ANN. AVG.	% OF ALT. 1
2 and 3	0	0	0	0	2	(1)	0	150	245	241	11	0	54	0.3
4	(389)	(693)	(491)	(904)	(992)	(1,111)	(1,801)	(2,101)	(2,319)	(2,037)	(1,112)	(755)	(1,225)	(7.8)

Differences in Impacts Between HYSSR and HYDROSIM (Negative Means HYSSR Difference is Larger)

Alternatives	SEP	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUNE	JULY	AUG	ANN. AVG.	% OF A1
2 and 3	(1)	(13)	(4)	(7)	(1)	(4)	0	(10)	(75)	(64)	(7)	(11)	(16)	(0.1)
4	31	(126)	(98)	300	(179)	(9)	225	308	96	94	(115)	(38)	42	0.3

3.1.5 Power System Models

The study team used several models in the analysis. Figure 3.1-3 provides a schematic of how the several models were integrated to estimate the range of net economic effects. Specifics of each model are provided in the technical report (DREW Hydropower Impact Team, 1999). In general, the results from the

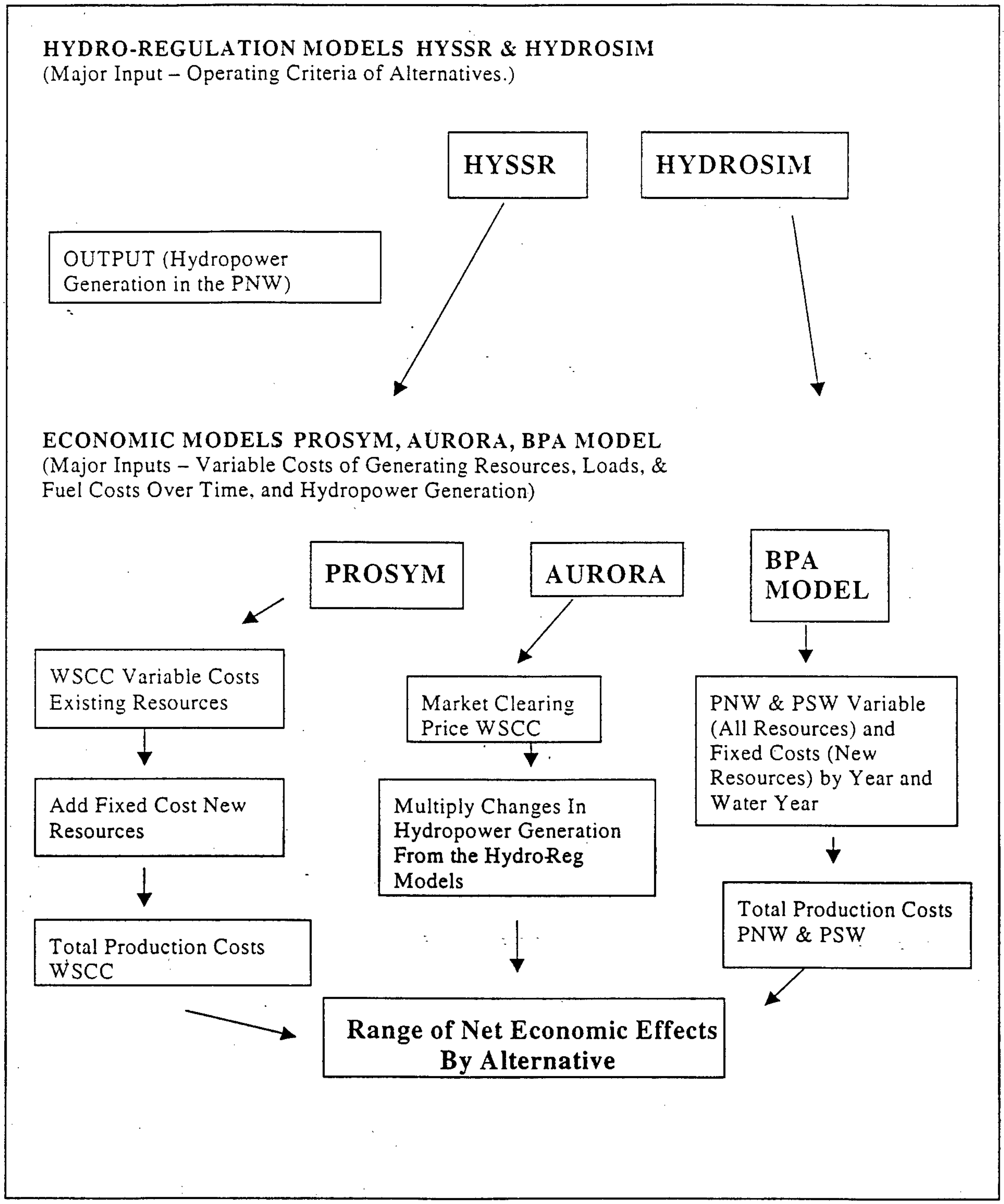

Figure 3.1-3. Schematic of Models Used in Hydropower Analysis

hydroregulation models were fed into the economic models. Each economic model was used to place a dollar value on the changes in hydropower production.

Because of the inter-related, market driven nature of the electric industry, it was decided that the evaluation of changes in hydropower production in the Pacific Northwest must be evaluated on a system-wide basis. This study uses two separate system production cost models, one by the Corps and one by BPA, to evaluate the net economic effects of changing power generation at the four lower Snake River facilities and John Day. A third approach developed by the Northwest Power Planning Council (NPPC) was also utilized in this study.

These multiple approaches were undertaken to look at the impacts from different analytical viewpoints to assure that the economic effects are adequately bracketed in the final estimates. The study progressed by examining model results for each alternative with the different system approaches. To the extent possible the basic input assumptions were standardized among the models, and these assumptions are discussed below. Upon comparing results, the study team built a consensus on the best analytical approach.

The evaluation of the net economic effects on hydropower was based on two basic approaches: a market price analysis and a system production cost analysis. The AURORA model served as the basic tool for the market price analysis, and the PROSYM and BPA models were used for the system production costs analysis. It is important to note that the market price and system production cost approaches are intended to measure the same net economic effects, and hence are directly comparable.

Many similarities do exist in the three power system models used in this analysis. They are all designed to identify how the different power generating resources will be operated to meet projected power loads (demand). They do vary in scope from hourly models (Aurora and PROSYM) to a monthly model that stratifies hours in the month into different blocks of peak and non-peak hours. The geographic regions covered by each model are different. The treatment of constructing new power resources and retiring power plants varies among the models. The primary outputs of each model are different. The Aurora model identifies the marginal cost in each period and this is assumed to be the market-clearing price. PROSYM provides the production costs (variable costs) to meet loads by all regions in the WSCC. The BPA model also identifies production costs but also provides the fixed costs of new resources to arrive at the total system production costs.

3.1.5.1 Market Price Model

The conceptual basis for evaluating the benefits from energy produced by hydropower plants is society's willingness to pay for the outputs, which sometimes can be obtained through market prices. With the movement towards a more competitive market, the price of electricity in the California market and elsewhere is being priced at or near the marginal production cost of the last resource to provide the needed electricity. So, this part of the power analysis looked at valuing the incremental changes of hydropower generation at the market price, which was based on the marginal cost of the last resource used to meet load in the specific time frame.

As more competitive electricity markets develop, prices will not be set to average costs as they have been in the past. Rather, the various services provided, operating reserves, voltage stabilization, etc., will be available and priced separately. However, consumers will not have to purchase all of these services from separate suppliers. During most time periods in the power spot market, the

generation price of electricity will be set by the operating costs of the most expensive generating unit needed to meet demand, or what is referred to in economics as the "marginal cost" of production. In general, a supplier will not be willing to sell power below the market price of the most expensive facility operating at a given time, because consumers will be willing to pay the higher price. Similarly, consumers will be unwilling to pay more than the cost of the most expensive operating available generator, since other suppliers will be offering lower prices. With prices set to marginal costs, the market will clear: all suppliers willing to provide power and all consumers willing to purchase power at the market price will be doing so.

Market prices were obtained from the NPPC study (NPPC, June, 1998) entitled "Analysis of the Bonneville Power Administration's Potential Future Costs and Revenues, 5 June, 1998." The market prices used in this study were developed with a model called Aurora, developed by a private firm, EPIS, Inc. The general elements of the Aurora model are provided here, and a more thorough description of Aurora is contained in the technical report (DREW Hydropower Impact Team, 1999). One of the principal functions of Aurora is to estimate the hourly market-clearing price at various locations within the WSCC.

Aurora estimates prices by using hourly demands and individual resource operating characteristics in a transmission-constrained chronological dispatch algorithm. The operation of resources within the WSCC is modeled to determine which resources are on the margin for each area in any given hour.

Aurora uses operating cost information for all the generating plants in the WSCC to build a least cost dispatch for the WSCC to meet energy demands. Units are dispatched according to variable cost, subject to non-cycling and minimum run constraints until hourly demand is met in each area. Transmission constraints, losses, wheeling costs and unit start-up costs are reflected in the dispatch. The market-clearing price is then determined by observing the cost of meeting an incremental increase in demand in each area. All operating units in an area receive the hourly market clearing price for the power they generate.

The hourly market clearing prices are developed on an area-specific basis. The analysis for this appendix uses the Oregon/Washington (OR/WA) area price to value Pacific Northwest generation. This price can be interpreted as the average busbar price as seen by generation in the OR/WA area. Charges for delivery within the OR/WA area are not included in the price.

3.1.5.2 System Production Cost Models

The other approach to define net economic effects was a system production cost analysis. The economic effects were identified by comparing system production costs with the level of hydropower production from the different alternatives being investigated. Changes in hydropower generation result in different levels of operation of more costly thermal generating power plants. Hence, the economic values of different increments of hydropower energy were defined by the displacement of thermal resource generation.

For this analysis the total system production costs are defined as the sum of the variable operating costs (production costs) and the fixed costs (annualized capital costs) of new resources added to meet loads. The total system is defined by different geographic regions in each model. However the basic definition is:

Total System Production Costs	=	**Variable Costs** (Production)	+	**Fixed Costs** (New Capacity)

Both BPA and the Corps have models that estimate the costs of meeting energy demand (loads) with available hydropower energy and thermal resources. The models identify the most cost-effective way to meet loads given all system constraints. These models estimate which resources will be operated to meet loads and the variable costs of these resources are summed to define variable production costs. Loads may also be met through purchase of energy from the Pacific Northwest, Pacific Southwest, or other regions. The purchase price reflects the variable generation costs and the transmission costs of the resource used to provide the energy. Production costs in the Pacific Northwest and Pacific Southwest will vary depending on how much Columbia River hydropower is generated. The output of hydroregulation models (HYSSR and HYDROSIM) served as the major input to the system energy production cost models.

The BPA model categorizes West Coast thermal resources into several production cost blocks based on the average efficiencies of the plants. The more inefficient plants tend to be the older plants that are operated last in the dispatch order. The BPA model compares the Pacific Northwest and Pacific Southwest loads to the monthly hydropower and thermal generation for each simulation year. As hydropower generation varies, the thermal generation amounts and costs change. The model identifies the marginal costs of the resources which hydropower will displace. The load is broken into three distinct periods of each week or month. These periods are the super peak (hours 7:00 a.m. to 10:00 a.m. and 5:00 p.m. to 8:00 p.m. each weekday), peak (hours 6:00 a.m. to 10:00 p.m. Monday through Saturday, not including the super peak hours) and non-peak hours (the remainder of the week). This stratification accounts for the significant variations in prices and resources used to meet loads in these different periods of the week.

The Corps utilized an existing proprietary hourly system production model entitled PROSYM, which has been used extensively by the Corps throughout the United States. PROSYM was developed and is maintained by Henwood Energy Services of Sacramento, California. The Corps used the model under a contract with Henwood. The PROSYM model has an extensive database, which includes operating characteristics of all WSCC power plants, current fuel prices, plant efficiencies, and inter-regional marketing conditions. The model dispatches thermal and hydropower resources on an hourly basis to meet energy demand. Hydropower resources are based on weekly energy amounts generated by the hydropower regulator models from the facilities in the study region, or weekly energy amounts input to the model. The model also includes a pollution emissions subroutine.

3.1.5.3 Model Inputs

This section describes the major inputs utilized by the system production cost models and the market price analysis. Most of these key model assumptions were taken from the NPPC's report "*Analysis of the Bonneville Power Administration's Potential Future Costs and Revenues, 5 June 1998*." A range of projections (low, medium and high) was made for each key variable to account for the uncertainty associated with predicting future conditions.

Elasticity of Demand. One major simplifying assumption made in this analysis is that consumers of electricity have a zero price elasticity of electricity demand. This assumption does not account for the probable reduction in demand for electricity that will occur if electricity prices increase with the implementation of Alternative 4, Dam Breaching. There is significant evidence that there is price elasticity for electricity at both the wholesale and retail level. But, it was considered beyond the scope of this study to estimate elasticity for each consumer type.

System Loads

The system loads, or power demands, are shown in Table 3.1-5 for the starting year of 1997, by each of the 12 Aurora demand regions.

Table 3.1-5. Aurora Model - 1997 Electric Loads by Demand Region

Region	Load (aMW)
OR/WA	16779
North CA	10730
South CA	16783
Canada	11842
ID	2644
MT	1554
WY	1455
CO	4681
NM	2106
AZ	6474
UT	2481
NV	2817
TOTAL	80346

Source: NPPC's study, "Analysis of the Bonneville Power Administration's Potential Future Costs and Revenues, 5 June 1998"

Demand was assumed to grow at equal rates in all of the demand areas. Although this will certainly not be the case, the team did not research every state's demand forecasts because these were likely to include a wide range of basic demographic assumptions. It was also felt that historical relative growth rates for states might not be a good indicator of future demand growth.

For the medium case, demand was assumed to grow at 1.5 percent annually. In the low case, the assumption was 0.5 percent per year, and in the high case it was 2.5 percent. The load forecasts project the Pacific Northwest demand in terms of average megawatts by year up to year 2020.

Fuel Prices

The major component of production cost of any power system is the costs of fuels expended to generate the electricity. Hence, the fuel prices assumed to occur over time are a critical element of the system production cost modeling and the market price analysis. This section describes the assumptions made for the fuel prices in the different regions of the WSCC.

Natural Gas Prices

The NPPC Aurora model is currently structured to develop its natural gas price assumptions based on two pricing points, Henry Hub in Louisiana and Permian in Texas. Prices in the Aurora regions are then based on a series of differentials from these trading hubs. The results of making the

differential adjustments are shown in Table 3.1-6. This table shows the assumed natural gas prices on a $/million BTU basis for 1997.

Table 3.1-6. Assumed 1997 Natural Gas Prices by Region

Regions	Estimated 1997 Price ($/mBTU)
Canada	1.45
BC Border at Sumas	1.70
Northwest from Alberta Eng Co. (AECO)	1.63
N. California from AECO	1.95
Utah	1.80
Colorado	1.95
Wyoming	1.80
Montana	2.00
Idaho	1.97
Southern California	2.15
Arizona	2.10
New Mexico	1.95
Nevada	2.00

The final assumption for natural gas prices was the real escalation rate applied to the gas prices. Three different future economic scenarios were projected. For the medium economic forecast case, it was assumed the medium gas price escalation included in the Council's power plan, 0.8 percent per year escalation above general inflation. The low forecast assumed a negative 1.0 percent real escalation rate, while the high projection assumed a positive 2.0 percent real escalation. These assumptions translate into similar growth rate in all regions with one exception. In 1999 and 2000 significant expansions to pipeline capacity to export from Alberta to the East are expected to come online. This expanded export capacity will have the effect of increasing prices in Alberta and British Columbia, perhaps significantly. To reflect this it was assumed that the basis differential from Canadian markets to Henry Hub decreases in the medium case. The Alberta Energy Company (AECO) Hub price in Alberta decreases from a negative $0.65 to a negative $0.45 by the year 2001. The Sumas differential decreases from a negative $0.55 to a negative $0.40 during the same period. These differential decreases result in significant increases to Northwest natural gas prices in the early years of the analysis. A range of natural gas assumptions is explored in the analysis as presented Table 3.1-7.

Oil Prices

For the base year of 1997 it was decided to use the starting crude oil prices at $3.50 per MMBtu with a low real escalation rate of 0.5 percent per year. This escalation rate was applied to all oil fuels. The 1997 starting values that were selected for other oil fuels are shown in Table 3.1-8.

Because oil prices do not appear to play an important role in determining the future market price of electricity, oil prices ranges were not used in the analysis.

Table 3.1-7. Summary of Natural Gas Price Assumptions

1997 Price	Low ($)	Medium ($)	High ($)
Henry Hub	1.80	2.00	2.25
Permian	1.60	1.80	2.15
Basis Differential			
AECO	-.65 constant	-.65 down to -.45	-.65 down to -.20
Sumas	-.55 constant	-.55 down to -.40	-.55 down to -.10
	(%)	(%)	(%)
Escalation Rates	-1.0	+0.8	+2.0

Table 3.1-8. Fuel Oil 1997 Prices Used in Analysis

Fuel Oil Type	1997 Price ($/MMBtu)
Crude Oil	3.00
#1 Fuel Oil	5.00
#2 Fuel Oil	4.50
#3 Fuel Oil	4.25
#4 Fuel Oil	3.85
#5 Fuel Oil	3.50
#6 Fuel Oil	2.70

Coal Prices

The other fuel, besides natural gas, that plays a significant role in the market price of electricity is coal. It was assumed that coal prices would decline in real terms in the base and low cases and to remain constant in the high case. In the low case coal prices were assumed to decline by 2 percent a year. In the base case, they decline at 1 percent a year. These growth rates were based on the Energy Information Administration's *Annual Energy Outlook*.

Resources; Existing and Future

To meet load growth over time it was necessary to project what kind of resources will be built in the future, and under what conditions these will be built. Each of the three models used in this analysis approached the addition of new thermal resources in different manners as discussed in the Fixed Production Cost section (Section 3.1.6.1). The type of resources to be added to the system was reviewed by the study team. It was found that the most predominate type of fuel plant that has been recently added to power systems on the West Coast have been natural gas-fired combined-cycle combustion turbine (CC) plants. It was found that CC natural gas plants represented the most cost-effective new additions over a wide range of potential plant factors. It was assumed in the Corps and BPA models that all new thermal resources to be built through year 2017 would be natural gas-fired combined cycle power plants.

The NPPC as part of its Power Plan responsibilities keeps abreast of the latest construction and operating costs for all potential resources. The construction costs identified for CC plants of 250 MW capacity in the West Coast region were estimated to be $601 per kW of installed capacity, at

the 1998 price level. The average heat rate of the new CC plants in 1998 was assumed to be 7,045 Btu/kWh. This heat rate was assumed to go down over time at the rate of change described in the next section. The construction costs were based on the most recent financing experienced by the industry. To include these costs in the annual simulations, the construction costs were adjusted to an annual fixed cost amount. The fixed costs used in the BPA model were in the 11.4 to 11.9 mills/kWh range, depending on the year of simulation. For comparison purposes the annualized values of the construction and fixed O&M costs for gas powered combined-cycle powerplants, computed from a model developed by FERC, were used only in the PROSYM studies. The annualized value used in the PROSYM study was $86/kW-yr delivered to the distribution system.

Combustion Turbine Costs and Technology

Because new capacity additions are comprised of CC power plants, an effort was made to develop plausible and consistent assumptions regarding the evolution of the cost and performance of these plants over the study period.

Continuing advances in aerospace gas turbine applications are expected to lead to further reduction in the cost and increases in the efficiency of power generation equipment. For this study, cost reduction assumptions are based on projected improvement in gas turbine specific power[1/]. Increases in specific power produce greater output with no increase in physical size, thereby reducing cost. Historical rates of improvement and estimated ultimately achievable rates of specific power suggest that over the study period specific power will continue to improve, on average, at constant rates. The resulting projections of annual cost reduction averaged a negative 0.6 percent in the Medium forecast, a negative 1.2 percent in the Low and a negative 0.1 percent in the High forecast. These reductions were applied to both capital and operating costs of new CC plants.

State-of-the-art combined-cycle efficiency is forecasted to continue to improve, but at declining rates. Rates of efficiency improvement are based on alternative introduction dates of advanced turbine technologies, and decades by which ultimate turbine efficiency might be achieved. Using this approach, combined-cycle plant efficiencies would improve from 48 percent in 1997 to 54 percent by 2020 in the Medium forecast, to 57 percent in the Low and to 53 percent in the High forecast.

Unserved Load

In each of the three models, not all load was met in each time period. The amount of load to be met by the available resources is a fixed input to each of the models. The models then identify the most cost-effective way to meet that load given the resources available to the model. System simulations are run with the different water years, and the amount of available energy to serve load can vary substantially with the different water years. Since the models were trying to meet load in every hour, or block of hours, there were instances in which not enough energy or capacity was available to meet each hourly demand.

Different approaches were taken to account for the economic costs of the unserved load. In the real world, if shortages like this occur, the system will start shedding loads by not meeting certain loads,

[1/] Specific power is the power output per unit mass of working fluid.

and curtailing the amount of energy provided in a particular time frame to some or all electric customers. There will clearly be an economic cost associated with this curtailment. One approach considered for this study was to simply assign a relatively high cost for every shortfall in satisfying the load. This high value was assumed to represent a proxy for the economic cost of curtailment. Another approach used was to recognize that demand-side management measures could be instituted to reduce peak load during these critical hours.

Although it is likely that the market will come up with innovative approaches to reducing peak demands in response to time of use pricing, it was assumed that the market could achieve up to 26 percent as the maximum peak reduction through demand side voluntary actions.

The NPPC developed a supply curve for demand-side resources based on the best available information. This supply curve was used in the Aurora model and is presented in Table 3.1-9.

Table 3.1-9. Demand-side Supply Curve

Step	Share of Potential (%)	Mills/KWh
Step 1	First 20	50
Step 2	Second 20	100
Step 3	Third 20	150
Step 4	Fourth 20	250
Step 5	Last 20	500
Step 6	Unserved Peak	1000

3.1.6 Net Economic Effects by Alternative

As described above, two different approaches were undertaken to estimate the net economic effects associated with changes in hydropower production in the Pacific Northwest system: production costs and market pricing.

3.1.6.1 System Production Costs Analysis

The economic effects provided in this section are based on the system production costs as defined by the two production cost models. A range of results is presented based on three assumptions of the key variables of fuel costs and loads. The future condition hereafter referred to as Low, combines the lowest estimate of fuel prices, the most rapid advancement in generation technology, and the low estimate of future load growth for all regions in the WSCC. Likewise, the Medium conditions combined the medium projections of fuel price, technology advancement, and load. The High condition combined the high projections of these three parameters.

Many of the tables in this section provide the description of total system production costs for each alternative as estimated by the BPA model and the PROSYM model. As can be seen from these tables, the BPA model was run over a much broader range of assumed conditions. This is a spreadsheet model, which has considerable flexibility. The PROSYM model is a much more complex hourly model, and time constraints did not allow for running this model for the full range of potential future conditions. Another major difference in the two models is that the BPA model was run for each of the 50 historic water years, while the PROSYM model was only run for an average water year based on the average of all 60 water years simulated by the HYSSR model. The

scope of the BPA model is the Pacific Northwest and California, while the PROSYM model includes all of the WSCC region.

The terminology used here refers to variable and fixed costs, and this is similar to the energy and capacity costs used in other studies. Energy is defined as that which is capable of doing work, and is measured over a time period. Electrical energy is usually measure in kilowatt-hours (kWh), megawatt-hours (MWh) or average MW (aMW - the average of MW produced over the entire year of 8,760 hours). Capacity is the maximum amount of power that a generating plant can deliver, usually expressed in kilowatts or megawatts. In the system production costs the variable costs are the costs associated with meeting energy requirements and they go up and down, as energy is needed to meet demand. The fixed costs are the costs needed to provide new capacity and this does not vary with hourly production. The fixed costs represent the annualized value of constructing the new capacity.

Variable Production Costs

The variable costs include the fuel costs and the variable operating costs of the many different thermal plants. If energy is transmitted between market regions, the cost associated with this transmission is also included in the variable production costs. Table 3.1-10 provides a summary of the variable production costs by generating resources as estimated by the BPA model for one specific year (2010), the medium forecast condition, the average of 50 water years, and two alternatives: Alternative 1, Existing Conditions, and Alternative 4, Dam Breaching. Table 3.1-11 provides the same type of information from the PROSYM model. These are provided as samples to demonstrate the nature of the estimated production costs for the Pacific Northwest and California in the BPA model and the entire WSCC in the PROSYM model. Similar results were computed for all the future years of 2002 to 2017, for the low, medium, and high conditions, and for each of the 50 water years with the BPA model. Comparing the total variable production costs for year 2010 for Alternative 1, Existing Conditions, and Alternative 4, Dam Breaching, shows that variable costs with Alternative 4, Dam Breaching, increase by $160 million and $202.6 million for the BPA and PROSYM models, respectively.

The results of the BPA model as shown in Table 3.1-10 are provided by resource type in the Pacific Northwest. Some thermal plants in the Pacific Northwest are classified as must run thermal which must be run due to the nature of the plant (i.e., nuclear) or long term contracts which require a constant level of production except during routine re-fueling and scheduled maintenance periods. The generation from these plants will not vary with the different alternatives, so the variable costs are not included in the table. The generation and variable costs from Pacific Southwest resources are presented in total in this table. The amount of generation from new CC plants is shown for Alternative 1, Existing Conditions, and Alternative 4, Dam Breaching. However, more new CC plants were assumed to be constructed with Alternative 4, Dam Breaching, to replace some of the lost hydropower generation and capacity. The costs associated with transmitting energy between regions are also reported in this table.

Table 3.1-10. BPA Model System Production Costs

Year 2010, With HYDROSIM & BPA Model, Medium Forecast

Variable Production Cost Summary With Alternative 1

		Variable Costs	Average Var. Costs
Pacific Northwest PLANTS:			
High Cost Coal	647	98.7	17.40
Low Cost Coal	2,414	207.0	9.79
Existing CT	55	11.2	23.26
Existing CC	1,594	214.7	15.37
New Region CC	5,135	609.4	13.55
Regional Firm Imports	1,477	120.0	9.27
Regional Hydropower	15,701	-	-
Curtailment/Demand-Side	89	48.7	62.72
TOTAL Pacific Northwest:	**27,113**	**1,309.7**	
Pacific Southwest PLANTS:			
Existing Resources	8,066	1,654.4	23.41
New Region CC	3,075	388.3	14.42
Curtailment/Demand-Side	103	50.9	56.21
TOTAL Pacific Southwest:	**11,244**	**2,093.7**	
TRANSMISSION COSTS		31.5	
TOTAL VARIABLE COSTS		**3,434.9**	

Variable Production Cost Summary With Alternative 4

		Variable Costs	Average Var. Costs
Pacific Northwest PLANTS:			
High Cost Coal	659	100.4	17.40
Low Cost Coal	2,436	208.8	9.79
Existing CT	53	10.8	23.26
Existing CC	1,658	223.4	15.37
New Region CC	6,063	722.9	13.61
Regional Firm Imports	1,480	120.3	9.27
Regional Hydropower	14,477	-	-
Curtailment/Demand-Side	78	42.9	63.10
TOTAL Pacific Northwest:	**26,904**	**1,429.5**	
Pacific Southwest PLANTS:			
Existing Resources	8,249	1,692.6	23.42
New Region CC	3,094	390.7	14.42
Curtailment/Demand-Side	111	54.9	56.52
TOTAL Pacific Southwest:	**11,454**	**2,138.2**	
TRANSMISSION COSTS		27.5	
TOTAL VARIABLE COSTS		**3,595.3**	

Differences from Alternative 1 (Alternative 4 - Alternative 1)

		Variable Costs	Average Var. Costs
Pacific Northwest PLANTS:			
Must Run	-	-	N/A
High Cost Coal	12	2	N/A
Low Cost Coal	21	2	N/A
Existing CT	(2)	(0)	N/A
Existing CC	64	9	N/A
New Region CC	928	114	N/A
Regional Import	3	0	N/A
Regional Hydropower	(1,225)	-	N/A
Curtailment/Demand-Side	(11)	(6)	N/A
TOTAL Pacific Northwest:	**(209)**	**120**	N/A
Pacific Southwest PLANTS:			
Must Run	-	-	N/A
Existing Resources	183	38	N/A
New Region CC	19	2	N/A
Curtailment/Demand-Side	7	4	N/A
TOTAL Pacific Southwest:	**209**	**45**	N/A
TRANSMISSION COSTS		(4)	N/A
TOTAL VARIABLE COSTS		**160.4**	N/A

Table 3.1-11. PROSYM Production Cost Summary by Area, Year 2010 Conditions—Average of Water Years, Medium Forecast Conditions. 1998 $ Million

Transmission Area	Alternative 1 Total Area Production Costs ($)	Alternative 3 Total Area Production Costs ($)	Alternative 3 minus 1 Area Production Costs ($)
Alberta	693.8	698.7	4.9
Arizona	1,977.0	1,977.1	0.1
BC Hydro	270.8	269.4	(1.4)
Comision Federal de Electricidad	681.0	674.8	(6.2)
Colorado/Wyoming	1,053.8	1,054.1	0.3
El Paso	97.2	97.1	(0.1)
Imperial Irrigation	51.3	51.3	(0.0)
Inland Northwest	543.7	553.3	9.6
Los Angeles Dept. of Water & Power	526.2	523.8	(2.4)
Montana	337.0	342.3	5.3
Northern California	3,266.9	3,272.3	5.4
Pacific Northwest	1,175.1	1,348.9	173.8
Palo Verde	978.3	978.2	(0.1)
Public Service of New Mexico	825.7	826.1	0.4
Southern California Edison	2,825.6	2,825.6	0.0
San Diego Gas & Electric	750.2	750.0	(0.2)
Southern Nevada	897.6	897.3	(0.3)
Utah	731.5	734.2	2.7
Wyoming	262.0	262.4	0.4
Total	17,944.7	18,136.9	192.2

One point of importance is how the loss in hydropower with Alternative 4, Dam Breaching (and other alternatives) is accounted for in these models. From Table 3.1-10 it can be seen that the HYDROSIM model estimated that with Alternative 4, Dam Breaching, that the amount of hydropower production was less than with Alternative 1, Existing Conditions, by 1,225 average MW. This difference in hydropower generation was made up by a combination of thermal alternatives (primarily natural gas-fired combined-cycle combustion turbines) at a higher cost. It is these higher variable costs that made up the increased production costs, and a large component of the net economic effects.

Table 3.1-10 demonstrates that with the breaching of the four lower Snake River dams and the building of additional CC plants in the Pacific Northwest, the total generation in the Pacific Northwest in year 2010 will be 209 aMW less than in the base condition. At the same time, the generation in the Pacific Southwest will increase by 209 aMW to meet the 2010 loads in the Pacific Northwest and Pacific Southwest regions. So, on an annual basis, the Pacific Northwest will import an additional 209 aMW from the Pacific Southwest in 2010 with Alternative 4, Dam Breaching.

The system variable production costs shown in Table 3.1-11 from the PROSYM model is the combination from each of the 14 transmission areas within the WSCC.

The variable costs for hydropower generation in both power production cost models are shown as zero for all alternatives. This is because there is no cost of fuel for hydropower. It is recognized that there will be some differences in fixed O&M and capital costs for hydropower between the different alternatives, but these are not included in this hydropower analysis. The implementation

costs analysis does include the differences in hydropower O&M and capital costs with all alternatives and including them in this hydropower analysis would have resulted in double-counting this impact. The interested reader is referred to the Implementation Cost section of this Appendix.

Fixed Production Costs

This section discusses the capacity costs, or the fixed costs. For either of the production cost models to meet the loads projected over time, new generating facilities will need to be constructed. With each alternative, a different mix of new generating facilities will be needed to account for the varying amounts of hydropower production. The decision of when and how much new capacity is to be built is an important element of the analysis.

On a simplified basis the market driven capacity addition decisions will probably be based on the following considerations. The market-clearing price for any selected time period will generally be based on the marginal costs of the last resource. Only during periods of extremely high demand (peak demand), typically on very hot summer (or cold winter) days, when the demand for electricity approaches the available generating capacity, would prices rise above the marginal costs of the most expensive generator operating. Because the amount of capacity available at any point in time is fixed, and new generating capacity cannot be built quickly, the only way in which demand and supply could be kept in balance during extremely high demand periods would be through an increase in the price, to a level that would encourage some consumers to reduce their usage. The frequency of these periods of high prices will help determine whether new generating resources will be built. The price adjustment during periods of peak demand can be thought of as representing the value consumers place on reliability.

This price signaling concept and the frequency of occurrence formed the decision criteria for construction of new resources in the BPA and Aurora models used in this power analysis. With these models new resources are assumed to be built when the marginal costs are sufficiently high and frequent to cover the cost of constructing the resource (in terms of the annualized fixed costs) and the variable operating costs. The BPA model, for example, first simulates each year without any new resources being added in that year. The model then tests to see if it is economically justified to add new resources. To be justified a new power unit must produce enough energy in that year at the marginal costs to equal or exceed the fixed and variable costs of the new resource. If the resource is economically justified it is added to resource mix and the model continues this process until an optimized amount of new resources is identified. The interest rates used in the BPA model for new capacity additions were based on the same financial assumptions used by the Pacific Northwest Power Planning Council in the last draft of the regional power plan. The interest rates were based the most recent interest rates experience by merchant plant operators.

This economic justification approach was used in this study to estimate how many new resources would be built with each of the study alternatives, on a year-by-year basis from the present to year 2017. The additional fixed costs are included as a component of the total system production cost for identifying the net economic effects of each alternative. These costs are similar to the traditional capacity costs identified in past studies. Table 3.1-12 presents the resource additions projected to occur based on the BPA model results, which were also used in the PROSYM analysis.

Table 3.1-12. Power Resource Additions by Alternative BPA Model Results for Specific Years

	2010			2018		
Alternative	Pacific Northwest (aMW)	Pacific Southwest (aMW)	TOTAL (aMW)	Pacific Northwest (aMW)	Pacific Southwest (aMW)	TOTAL (aMW)
1	5,390	3,260	8,650	8,720	8,770	17,490
2 and 3	5,380	3,190	8,570	8,710	8,760	17,470
4	6,210	3,260	9,470	9,700	8,750	18,450
			DIFFERENCE FROM BASE CONDITION (aMW)			
2 and 3	(10)	(70)	(80)	(10)	(10)	(20)
4	820	-	820	980	(20)	960
			DIFFERENCE FROM BASE CONDITION (MW)			
2 and 3	(10)	(80)	(90)	(10)	(10)	(20)
4	890	-	890	1,070	(20)	1,040

Note: Includes all capacity additions up to and including this year.

It should be noted that this analysis identified only one power replacement scenario in which energy and capacity losses were replaced with natural gas fired CC plants. This was done because these were determined to have the lowest costs without considering any costs for the resulting increase in air pollution. Clearly, other options for replacement power could be considered and these could have lower air quality impacts, but they would likely have higher costs. Such options could include conservation. The Hydropower Impact Team is investigating the possibility of a conservation option, but this analysis was not completed in time for this appendix.

Total System Production Costs

Table 3.1-13 summarizes the total system production costs compared to Alternative 1, Existing Conditions, from the two models for year 2010, the medium projection condition, and the average over all water years. The total system production costs includes the variable costs of operating all the resources in year 2010 (column 2) and the fixed costs (column 4) associated with the additions of new resources that are needed to meet the projected load in that year. The variable costs in any given year include the operating costs for the resources added that year, and all resources in place in that year including new resources built prior to that date. The fixed costs are the annualized capital costs of new capacity. For example, with the BPA model the 820 aMW of new capacity under Alternative 4, Dam Breaching, was added up to year 2010 over the base condition. The annual fixed costs of this additional capacity was $88 million. The total system production costs in 2010 for Alternative 4, Dam Breaching, were the combination of the variable costs of $160 million and the fixed costs of $88 million.

Table 3.1-13. Hydropower Analysis: Total System Production Cost Summary

Alternative	Variable Production Costs (1998 $ Million)	Additional CC Capacity 1/ (aMW)	Additional Annual Fixed Costs (1998 $ Million)	Total System Production Costs (1998 $ Million)
HYDROSIM & BPA Models				
2 and 3	(0)	(80)	(8)	(8)
4	160	820	88	248
HYSSR & PROSYM Models				
Alternative	**Variable Production Costs (1998 $ Million)**	**Additional CC Capacity 1/ (aMW)**	**Additional Annual Fixed Costs (1998 $ Million)**	**Total System Production Costs (1998 $ Million)**
2 and 3				
4	203	820	77	280

1/ Includes all capacity additions up to and including this year. This is average MW. To determine total new capacity, divide by the availability factor of 92 percent. For example, for A3 the new capacity up to and including 2010 is 890 MW (820/.92)

Note: Year 2010 simulation, medium forecast conditions. Costs compared to Alternative 1, Existing Conditions.

Table 3.1-14 presents the system production costs on a year-by-year basis for the medium projection condition. This table also provides the total present worth values for each alternative and the average annual costs based on the three different discount rates.

Table 3.1-15 provides the average annual production cost for each alternative and the low, medium, and high projection conditions.

The comparison of the BPA and PROSYM production cost models can be made with results shown in Tables 3.1-13 and 3.1-14. Because PROSYM is much more complicated model to operate, and the results were similar to the BPA model, it was not run for all study alternatives. PROSYM modeling was limited to the medium forecast conditions and average water year. Consequently, many of the tables in this section do not include PROSYM results for all scenarios. However, the study team considered the PROSYM results to be a valuable crosscheck of the other modeling results and it was a useful tool to test many elements of this study.

Table 3.1-14. Hydropower Analysis: Total System Production Costs Over Time

Year	A2 ($ million)	A3 ($ million)
	HYDROSIM & BPA Model	
2005	0	0
2006	0	0
2007	0	242
2008	(8)	244
2009	(8)	246
2010	(8)	248
2011	(8)	249
2012	(9)	251
2013	(9)	253
2014	(9)	254
2015	(9)	257
2016	(9)	259
2017	(9)	261
2018	(9)	261
2019 - 2104	(9)	261
Results:		
NPV at 0%	(936)	25,963
NPV at 4.75%	(191)	5,347
NPV at 6.875%	(132)	3,705
Avg Annual at 0%	(9)	260
Avg Annual at 4.75%	(9)	256
Avg Annual at 6.875%	(9)	255
	HYSSR & PROSYM	
2005	N/A	0
2006	N/A	0
2007	N/A	239
2008	N/A	253
2009	N/A	266
2010	N/A	280
2011	N/A	283
2012	N/A	286
2013	N/A	289
2014	N/A	291
2015	N/A	294
2016	N/A	297
2017	N/A	300
2018	N/A	300
2019 - 2104	N/A	300
Results:	N/A	
NPV at 0%	N/A	29,779
NPV at 4.75%	N/A	5,526
NPV at 6.875%	N/A	3,658
Avg Annual at 0%	N/A	298
Avg Annual at 4.75%	N/A	265
Avg Annual at 6.875%	N/A	252

Note: Differences from Alternative 1. 1998 real million dollars, starting at in-service date, medium production cost assumptions.

Table 3.1-15. Hydropower Analysis: Average Annual Total System Production Costs

Average Annual Costs at Discount Rate 6.875%					
	Production Costs HYDROSIM & BPA Model ($)			Production Costs HYSSR & PROSYM ($)	
Alternative	Low	Med	High	Alternative	Med
2 and 3	(6)	(9)	(12)	A2	
4	187	255	329	A3	252
Average Annual Costs at Discount Rate 4.75 %					
	Production Costs HYDROSIM & BPA Model ($)			Production Costs HYSSR & PROSYM ($)	
Alternative	Low	Med	High	Alternative	Med
2 and 3	(6)	(9)	(12)	2 and 3	
4	187	256	332	4	265
Average Annual Costs at Discount Rate 0 %					
	Production Costs HYDROSIM & BPA Model ($)			Production Costs HYSSR & PROSYM ($)	
Alternative	Low	Med	High	Alternative	Med
2 and 3	(6)	(9)	(13)	2 and 3	
4	186	260	339	4	298

Note: Results from two different models. 1998 real million dollars, various in service dates, 100-year analysis. All amounts are cost differences from Alternative 1, Existing Conditions..

3.1.6.2 Market Price Analysis

The electric industry is moving towards a more competitive market, but is currently in a transition period which mixes wholesale pricing at marginal costs with most retail pricing based on average costs, and established contracts that may or not reflect either of these approaches. For these reasons, this appendix provides results from the two approaches of system production costs in the previous section and the market prices in this section.

To evaluate each of the alternatives, the market prices from Aurora, as defined by the marginal costs, are applied to the difference in Pacific Northwest hydropower generation from the base condition (Alternative 1, Existing Conditions). Since the marginal cost varies by transmission area and by time periods, the study team had to select which market prices would be most appropriate to evaluate impacts. The study team chose to multiply changes in Pacific Northwest hydropower generation by the Aurora market price developed for the states of Oregon and Washington. This price most accurately reflects the value of Pacific Northwest energy.

The marginal costs vary by hour, by day, and by month. To simplify the analysis hourly prices were allocated to peak and non-peak periods and averaged for each month to obtain estimates of peak and off-peak prices. Table 3.1-16 provides the monthly on-peak and off-peak market price defined by Aurora, for the medium projection condition, for the two specific years of 2005 and 2010, in nominal prices and real 1998 dollars. The general trend over time of the market prices based on the marginal costs was towards the marginal costs associated with CC. This was expected because of the study assumption that all new resources would be CC. As the new CC plants become a larger share of the resource mix they are operated more and replace inefficient thermal plants as the marginal cost resource.

These prices are assumed to reflect normal market conditions in the future based on the long term market developments. Any examination of the market prices recently seen on the California exchange market will demonstrate fairly wide-swings in market prices at different times of the year. These price swings are expected in any real world market, but cannot be accurately forecasted with the long term modeling tools used in this analysis.

Table 3.1-16. Hydropower Analysis: Average Market-Clearing Prices From NPPC Study

Medium Projection Condition For Two Years (mills/kWh)

YEAR 2005

Month	On-Peak (Nominal $)	Off-Peak (Nominal $)	On-Peak (1998 $)	Off-Peak (1998 $)
Sep.	42.39	31.55	35.66	26.54
Oct.	32.32	28.60	27.19	24.06
Nov.	33.78	28.14	28.42	23.68
Dec.	37.58	32.81	31.62	27.60
Jan.	36.87	32.46	31.02	27.30
Feb.	34.63	29.97	29.13	25.21
Mar.	26.77	26.35	22.52	22.17
Apr.	25.95	20.02	21.83	16.84
May	20.05	18.17	16.87	15.29
June	24.37	17.59	20.50	14.80
July	32.10	25.32	27.00	21.30
Aug.	43.39	31.32	36.50	26.35
Avg.	32.52	26.86	27.36	22.60

YEAR 2010

Month	On-Peak (Nominal $)	Off-Peak (Nominal $)	On-Peak (1998 $)	Off-Peak (1998 $)
Sep.	54.40	32.79	40.45	24.38
Oct.	32.89	29.29	24.45	21.78
Nov.	36.13	31.01	26.87	23.06
Dec.	39.13	32.77	29.09	24.37
Jan.	37.78	35.20	28.09	26.18
Feb.	38.83	31.05	28.88	23.09
Mar.	36.58	27.14	27.20	20.18
Apr.	31.01	20.16	23.06	14.99
May	18.81	18.44	13.99	13.71
June	22.05	17.56	16.40	13.06
July	27.06	27.61	20.12	20.53
Aug.	41.35	39.91	30.74	29.67
Avg.	34.67	28.58	25.78	21.25

The average monthly prices for peak and non-peak were used to identify the economic effects associated with changes in hydropower generation. This was done by computing the change in hydropower generation from the current conditions, by subtracting the Pacific Northwest

hydropower generation with each alternative from the base condition (Alternative 1, Existing Conditions). Adjustments were also made to the monthly hydropower generation by separating it into peak and non-peak hours based on the historic distribution shaping of the monthly hydropower generation. Table 3.1-4 presented the hydropower generation changes for each alternative based on average monthly generation. Table 3.1-17 multiplies the projected market price (from Table 3.1-16) by the changes in hydropower output from the base condition using both HYSSR and HYDROSIM outputs. This table labels the economic effects as net economic costs to represent changes from the base condition.

Table 3.1-18 provides the average annual net economic costs based on the market price analysis, by different discount rates, by the two hydroregulation models, and for the high, medium, and low economic forecast conditions. The values in this table were based on the differences from the base condition (Alternative 1, Existing Conditions). The results from the different hydroregulation models of HYDROSIM and HYSSR are not significantly different.

3.1.6.3 Reliability and Capacity Effects

This section describes how the changes in the hydropower capacity in the Pacific Northwest were investigated. Of particular interest is how will hydropower capacity reductions impact the generation reliability in the region and the WSCC in total, and to what extent additional thermal capacity will be built to replace losses in hydropower capacity.

To simplify the approach the reliability of the system is broken into two components for this examination: generation reliability and transmission reliability. This section concentrates on the reliability of the generation capacity of the system. The following section will address the impacts that different alternatives will have on transmission reliability. It was assumed here that transmission reliability will not be allowed to change from existing conditions for any of the alternatives, and the costs of maintaining this transmission reliability are presented in section 3.1.7.

Generation reliability can be evaluated numerous ways, but all approaches are generally based on how well the available generating resources can meet load in all time periods. In the Pacific Northwest the generation reliability of the power system primarily depends on the availability of water to generate hydropower. The scheduled and unscheduled (forced) outages of resources are also a significant component of any generation reliability analysis. The system power models used in the analysis account for the forced outages by either including random outages or de-rating the units. For example, the BPA model de-rates the new CC units by 5 percent to account for the probability of unscheduled outages and an additional 3 percent for the scheduled maintenance. The PROSYM model incorporates forced and maintenance outages on a plant by plant basis based on outages common to the different type of resources.

Traditionally, the Pacific Northwest generation reliability has been defined considering the dependable capacity of the hydropower system based on critical water conditions and high demand periods. This type of "firm planning" analysis has taken several forms over the years, all of which were geared towards assuring that loads are met with available generation with a high level of probability. However, as with other issues addressed in this appendix, the movement to a competitive electricity market affects how to analyze the issue of reliability and replacement capacity. With less regulation of the electrical industry and more independent power producers, many experts feel that market conditions

Table 3.1-17. Hydropower Analysis: Net Economic Costs Computed From Market Prices

HYDROSIM		
	Alternatives	
Year	1 ($ million)	2 and 3 ($ million)
2005	0	0
2006	0	0
2007	0	237
2008	(8)	227
2009	(8)	226
2010	(7)	223
2011	(7)	231
2012	(7)	226
2013	(7)	223
2014	(7)	222
2015	(7)	218
2016	(7)	222
2017	(7)	216
2018	(7)	216
2019 - 2104	(7)	216
Results:		
NPV at 0%	(698)	21,719
NPV at 4.75%	(148)	4,586
NPV at 6.875%	(104)	3,213
Avg Annual at 0%	(7)	217
Avg Annual at 4.75%	(7)	220
Avg Annual at 6.875%	(7)	221
HYSSR		
Year	2 and 3 ($ million)	4 ($ million)
2002	0	0
2003	0	0
2004	0	0
2005	0	0
2006	0	0
2007	0	228
2008	(10)	235
2009	(10)	230
2010	(10)	227
2011	(10)	227
2012	(10)	223
2013	(10)	226
2014	(9)	220
2015	(9)	220
2016	(9)	220
2017	(9)	220
2018	(9)	220
2019 – 2104	(9)	220
Results:		
NPV at 0%	(943)	22,109
NPV at 4.75%	(199)	4,672
NPV at 6.875%	(140)	3,274
Avg Annual at 0%	(9)	221
Avg Annual at 4.75%	(10)	224
Avg Annual at 6.875%	(10)	225

Note: Market clearing price multiplied by change in hydropower. Differences from Alternative 1, Existing Conditions. 1998 real million dollars, starting at in-service date. Medium condition projections.

Table 3.1-18. Hydropower Analysis: Average Annual Net Economic Costs From Market Prices

Average Annual Costs at Discount Rate 6.875%							
HYDROSIM & Aurora Prices ($)				HYSSR & Aurora Prices ($)			
Alternative	Low	Med	High	Alternative	Low	Med	High
2 and 3	(5)	(7)	(12)	2 and 3	(7)	(10)	(16)
4	151	221	347	4	154	225	353

Average Annual Costs at Discount Rate 4.75%							
HYDROSIM & Aurora Prices ($)				HYSSR & Aurora Prices ($)			
Alternative	Low	Med	High	Alternative	Low	Med	High
2 and 3	(5)	(7)	(12)	2 and 3	(7)	(10)	(16)
4	148	220	347	4	151	224	353

Average Annual Costs at Discount Rate 0%							
HYDROSIM & Aurora Prices ($)				HYSSR & Aurora Prices ($)			
Alternative	Low	Med	High	Alternative	Low	Med	High
2 and 3	(5)	(7)	(12)	2 and 3	(6)	(9)	(16)
4	141	217	346	4	143	221	353

Note: 1998 real million dollars, various in-service dates, 100-year analysis. All amounts are cost differences from Alternative 1, Existing Conditions.

will be the driving force to determine when new resources will be built. The expectation is that, in a competitive market, the decision to build new resources will be based on economic return rather than some regulatory convention. This assumption provided the conceptual basis for the reliability and replacement capacity portion of this appendix.

On a simplified basis the market driven capacity addition decisions will probably be based on the following considerations. The market-clearing price for any selected time period will generally be based on the marginal costs of the last resource. Only during periods of extremely high demand (peak demand), typically on very hot summer (or cold winter) days, when the demand for electricity approaches the available generating capacity, would prices rise above the marginal costs of the most expensive generator operating. Because the amount of capacity available at any point in time is fixed, and new generating capacity cannot be built quickly, the only way in which demand and supply could be kept in balance during extremely high demand periods would be through an increase in the price, to a level that would encourage some consumers to reduce their usage. The frequency of these periods of high prices will help determine whether new generating resources will be built. The price adjustment during periods of peak demand can be thought of as representing the value consumers place on reliability.

This price signaling concept and the frequency of occurrence formed the decision criteria for construction of new resources in the BPA and Aurora models used in this power analysis. With these models, new resources are assumed to be built when the marginal costs are sufficiently high and frequent to cover the cost of constructing the resource (in terms of the annualized fixed costs) and the variable operating costs. This economic justification approach was used in this study to estimate how many new resources would be built in each of the study alternatives, on a year-by-year basis from the present to year 2017. The additional fixed costs are included as a component of the

total system production cost for identifying the net economic effects of each alternative. These costs are similar to the traditional capacity costs identified in past studies.

Several important elements of this generation reliability approach had to be considered by the study team. Of most interest in this analysis was. (1) the treatment of periods in which existing resources were insufficient to meet electricity load. and (2) consideration of system reserves requirements and dependable capacity.

Unserved Load and Demand-Side Resources. The model simulations of Pacific Northwest and WSCC systems identified time periods in which the projected load exceeded the amount of energy available to meet this load. When this situation occurred, the models reported this as unserved load and the number of megawatt hours in which this occurred was tabulated. In general the unserved load occurred in the model simulations during low water periods of the year. in low water years, and periods of high demand. How to treat this unserved load is a critical element of the generation reliability issue.

One approach considered for treating the unserved load in this analysis was to assume that a curtailment in energy provided will occur and the user will suffer the economic losses. The appropriate value to assign to this curtailment is not known, but in some studies it has been assigned a relatively high value that exceeds the marginal costs of all thermal resources. This approach was used in the PROSYM model.

The approach that was used with the Aurora and BPA models recognized that market prices will affect power demands, and included demand-side management measures as potential resources to address unserved loads. Instead of assuming curtailments will occur, the Aurora and BPA analyses assumed demand-side actions would be taken first to meet some of the peak demands. Section 3.1.5.3 described how the potential size of demand-side resources and their marginal costs were defined for this study. These resources were priced in blocks with each successive block being more costly. The demand-side resources were treated like any other resource in the dispatching routines. During periods of high demand when thermal and hydropower resources are nearing full dispatch, the models dispatch the blocks of demand-side resources as needed to meet load. The demand-side resources are considered in defining the marginal costs and production costs in the two models.

Since the demand-side resources are priced at relatively high levels, the extent to which they are dispatched will influence the optimizing routines and consequently help determine how many new resources would be built. The Aurora and BPA models utilized the demand-side resources in the dispatch routines and the optimizing routine for additional resources. Table 3.1-12 showed the amount of new thermal resources that were added by the BPA model for specific years of simulations, by alternative, and by the regions of the Pacific Northwest and Pacific Southwest. A sensitivity test was done by the study team to find out to what extent the pricing of the unserved load and demand-side resources influenced the amount of new generation capacity that would be built and the total system production costs.

As discussed above, the unserved load was met in the BPA and Aurora models by demand-side resources that were valued in blocks. The range of values (marginal costs) were from 50 to 500 mills/kWh depending on the size of unserved load. If any unserved load still occurred after dispatching all demand-side resources, it was assigned a marginal cost of 1,000 mills/kWh. To determine how significant these assumed block sizes and prices were, a test analysis was undertaken. In this test the BPA model was run by replacing all costs of demand-side resources and

any unserved loads with a cost of 5,000 mills/kWh. As expected, with this higher cost for unserved load, more new resources were found to be economical and were added by the model. In the test case the amount of new CC resources built in year 2010 was 15,690 aMW in the Pacific Northwest and Pacific Southwest with Alternative 1, Existing Conditions, and 16,420 aMW with Alternative 4, Dam Breaching. This is an increase from the original analysis of 7,040 and 6,950 for Alternative 1, Existing Conditions, and Alternative 4, Dam Breaching, respectively.

The increase in the amount of new resources in the test case reflected that new resources could capture the high values to a large enough extent to economically justify their construction. The amount of new resource additions is not the only significant factor to examine. The total system production costs in the test and the original cases were also compared. The total system production costs with the test case increased significantly due to the costs of adding about 7,000 additional aMW of new CC capacity. However, the variable production costs, relative to the original case, dropped in the test case. The new CC resources (about 7,000 aMW in the test case) are more efficient and have lower variable costs than many of the existing resources in the resource mix. With more of these relatively efficient resources available for the model (in the test case) to dispatch to meet the load, the use of older resources with higher variable costs was reduced.

The changes in total system production costs between Alternative 1, Existing Conditions, and Alternative 4, Dam Breaching, under both cases yielded some interesting results. Generally, it was found that losing the lower Snake River powerplants in a system with lots of excess capacity is not as costly as losing the plants in the original case.

In conclusion, this test showed that the treatment of the value the unserved load in the model influences the amount of new thermal resources that are built by the model. Assigning a very high value to unserved load will result in more new CC capacity and substantial increases in the total system production costs (i.e., variable costs + fixed costs). However, the increase in fixed costs from adding more CCs are partially offset by reduced variable production costs. It was found that in both the test and original cases the total system production costs increased with the breaching of the lower Snake River dams. However, the valuing of unserved load did somewhat influence the magnitude of the total system production costs associated with breaching the dams. The significance of this influence appeared to be relatively small when compared to the substantial increase in the value of unserved load used in the test case. But, the study team decided to further examine the relationship of increasing fixed cost and reducing variable costs with capacity additions. The next section examines the significance of capacity additions to total system production costs.

System Reserves and Dependable Capacity Examination. As with any assessment of system reliability, criteria of acceptable reliability need to be devised and defined. Various criteria have been used historically in California and elsewhere in the West. These criteria have differed depending on the type of study, planning or operating, and the time period of the study. One measurement tool has been the planning reserve margin, which is expressed as a percentage of generation capability in excess of peak demand. The "correct" level of planning reserves in a deregulated market has yet to be established, and many argue that this level should be an economic decision made by market participants.[2/]

[2/] California Energy Commission. Karen Griffin, Memorandum 14 April 1998. Generation Reliability Study for ISO.

The type of criteria that may be developed in the future is hard to determine at this time. The WSCC has operated under a number of voluntary criteria and these reliability criteria are currently under examination for revision. Based on all these proposals and their uncertainty, any attempt at this time to specifically define a set of reliability criteria would be subject to criticism and would be likely to change before any of the lower Snake River alternatives could be implemented. For this reason, the study team examined the effects of different reliability criteria on the net economic effects. In particular the team looked at Alternative 4, Dam Breaching (changes from Alternative 1, Existing Conditions) with medium economic forecasts, in a specific year of 2010. Varying levels of additional new generating capacity were examined with the BPA and PROSYM models. The different amounts of new capacity resulted in different levels of system reserves (hence reliability) in the Pacific Northwest and different system production costs.

The amount of additional CC generation capacity assumed to be built by year 2010 under Alternative 4, Dam Breaching, was computed by the BPA model to be 890 MW as shown in Table 3.1-12. Higher and lower amounts of CC additions were examined. Utilizing the BPA model the several different levels of new capacity were modeled to see how total system production costs (variable costs + fixed costs of new resources) would change. In addition, a scenario in which no additional resources were added above those assumed to occur with Alternative 1, Existing Conditions was also tested.

Figure 3.1-4 shows the results from the BPA model for these different scenarios. The figure shows the variable costs (production costs), the fixed costs (new capacity costs), and the total costs (total system production costs). This figure also shows the capacity addition level in which total system production costs are at their minimum. It can be concluded from this figure that the addition of 890 MW (820 aMW) of new capacity is at or near the point of economic optimum (point of minimal net economic costs). This was expected because the BPA model utilized an optimization routine to define the 890 MW level. One interesting point from this figure is at around 2700 aMW of new additions the system variable costs go below zero. This means that if enough new CC plants are added to the system, with the breaching of lower Snake River dams, the system production costs (variable costs) will be less than if the dams were not breached. However, the fixed costs of these high level of capacity additions are so large that the total system production costs (variable + fixed) are much higher (about $300 million annually) than the base condition. The relatively flat slope of the total cost curve suggests that the selection of the most appropriate new capacity level may not be an extremely sensitive element of the hydropower study.

This same type of analysis was done with the PROSYM model. The PROSYM model provides the planning reserve margin for each of the transmission areas in the model. The planning reserve margin is the percent of generation capacity in excess of the highest peak load hour in the year. The planning reserve margins for all regions except the Pacific Northwest were the same for Alternative 1, Existing Conditions, and Alternative 4, Dam Breaching. Three different levels of new capacity were examined. The resulting planning reserves in the Pacific Northwest for year 2010 were estimated at 4 percent, 10 percent, and 12 percent for CC additions of 890 MW, 2640 MW, and 3250 MW, respectively.

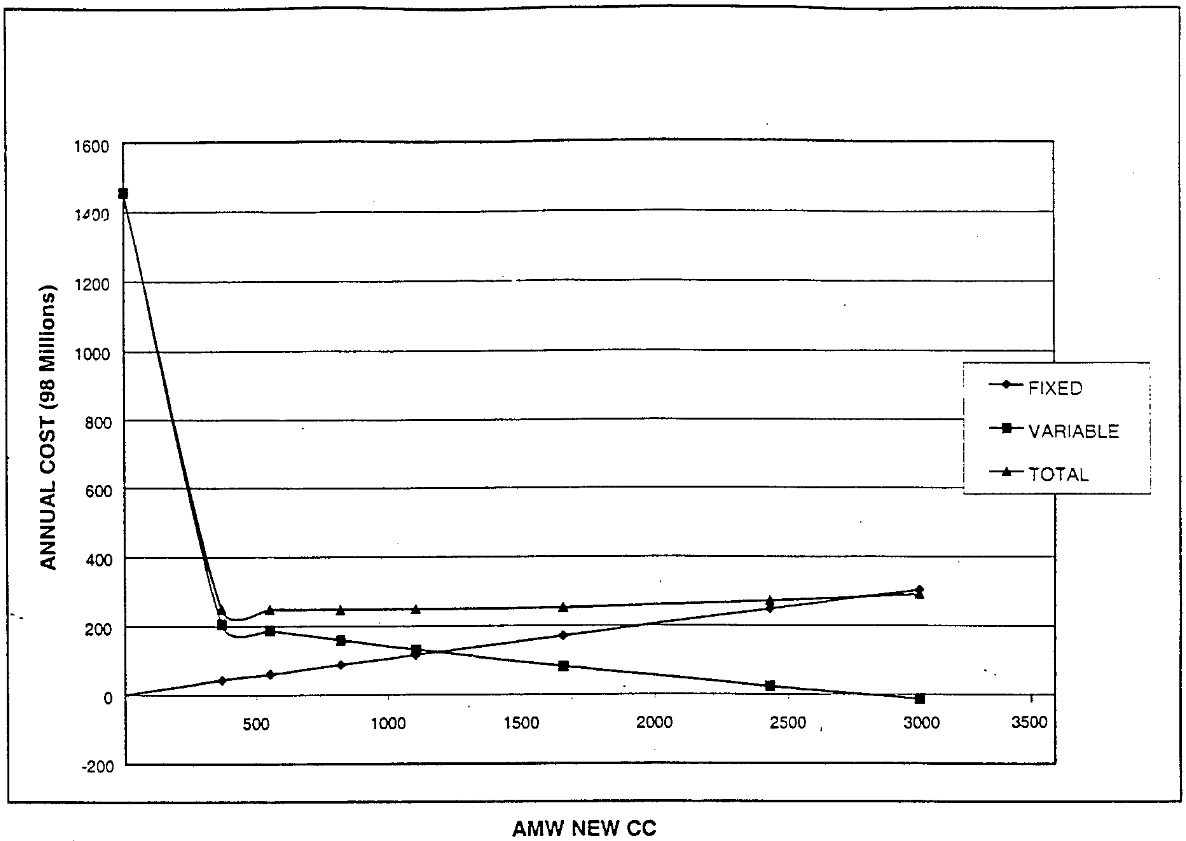

Figure 3.1-4. Total System Production Costs with Different Additions (YR 2010) Increases in A3 from A1 with BPA Model

Note: The dip in the curve at approximately 550 aMW is a software graphing anomaly — Actual minimum is at 820 aMW.

Reliability and Capacity Conclusions. This section presented the basic elements of the study dealing with additions of new generating capacity to replace the lost capacity associated with the breaching of the four lower Snake River dams. The replacement of the lost capacity relates to the general reliability of the power system over time and to what extent the market might pay for additional reliability. One complicating element of this hydropower analysis was the projection of what society might pick as the most appropriate reliability criteria in the study period of 2005 and beyond. The approach used in this study to estimate what level of new capacity would be built was to do an economic optimization to determine what level of new resources could be economically justified for construction. The study team, however, wanted to test the study results against other possible levels of new capacity and related generation reliability.

The study team was concerned whether different levels of replacement capacity and different approaches to the treatment of unserved loads would significantly change the estimates of increased system production costs. These two factors were tested with different approaches that lead to different levels on new capacity and planning reserve margins. With the higher levels of new generating capacity, the planning reserves were higher but so were the total system production costs. However, it was found that the total system production costs were not extremely sensitive (on a percentage basis) to different levels of assumed new generating capacity. So, the study team was satisfied that the capacity addition approach used in this analysis represented a reasonable estimate of the economic effects associated with the alternatives.

3.1.7 System Transmission Effects

The analysis of power system effects up to this point assumed that transmission reliability and service would remain the same under all alternatives. The purpose of this section is to identify the costs associated with maintaining transmission reliability with all the alternatives. This section investigates the impacts that Alternative 4, Dam Breaching, would have on the Northwest transmission grid. Alternative 2, Maximum Transport of Salmon and Alternative 3, Major system Improvements are not expected to have any significant impact to the transmission grid.

Alternative 4, Dam Breaching would breach the four lower Snake River dams, rendering the powerhouses inoperable, and thereby altering the source of power generation that feeds into the Northwest transmission grid. Since the transmission grid was originally constructed in combination with the generation system and since they interact electrically, loss of generation would affect the transmission system's ability to move bulk power and serve regional loads.

The transmission analysis looked at transmission system impacts with and without replacement generation. Both transmission system reinforcements and generation additions were evaluated to mitigate the transmission system impacts caused by breaching the four lower Snake River dams. The initial phase of this transmission study assumed no replacement generation for the dams that are breached. The transmission improvements needed to maintain reliable service were then identified and costs estimates were prepared. However, it was recognized that the construction and location of replacement generating resources would have a profound effect on the transmission system impacts and reinforcement needs and may provide a most cost-effective solution. This phase of the study was done separately from the energy supply additions shown in Table 3.1-12. The energy supply studies indicated that Alternative 4, Dam Breaching would require 890 MW of new CC generation in 2010 to replace lost hydropower. This transmission study evaluated transmission system requirements if replacement generation were constructed in a location where it would provide transmission system benefits to mitigate the loss of hydropower. To the extent that more than 890 MW of new CC generation will be required for transmission reliability, the additional costs are added to the transmission impacts.

Preliminary cost estimates for capital additions are included in this summary. These costs are based on preliminary studies using typical costs for facilities. A range of cost is given since there is much uncertainty about the scope of the projects, routes, etc., which could affect project cost.

Transmission impacts were examined for two seasonal conditions, the summer and the winter peak situations. The following defines the expected impacts and the possible solutions. The study approach was to first identify the impact to the transmission system, then the possible solutions were examined. The final step of the analysis was to select the most cost-effective measure to address the identified transmission impact.

3.1.7.1 Summer Impacts

The summertime peaks are the largest in the Pacific Southwest and transmission from the Pacific Northwest over the California-Oregon Intertie/Pacific Direct Current Intertie (COI/PDCI) is important to meeting the Pacific Southwest demands.

Northwest to California Transfers

If the lower Snake River dams were breached and not replaced, the COI/PDCI transfers limits would decrease by 200 MW (from 7200 to 7000 MW). This would limit the ability to sell and transfer Pacific Northwest generation to the Pacific Southwest to meet peak demands. Three possible solutions were postulated: 1) Reduce the COI/PDCI capacity by 200 MW and incur losses in sales. The economic costs of this approach were not quantified. 2) Upgrade the COI/PDCI intertie to maintain its capacity at a cost of $65 million to $85 million. 3) Site thermal replacement plants in the locations that would reinforce intertie transfer capabilities. Further study of summer solutions to the Pacific Northwest to California impacts was not done since it was realized that the solutions to the summer impacts may be unnecessary because the solutions to the winter problems could also correct the summer impacts.

Northwest Regional Impacts

With the breaching of the four lower Snake River dams, there would be more stress on the transfer capability in the upper mid-Columbia area. Two transmission system cutplanes, north of John Day and north of Hanford, would be impacted. (A cutplane is a group of transmission lines whose total loading is an indicator of system stress.) These particular cutplanes measure how much power is flowing from the Upper and Mid Columbia area to COI/PDCI. With the elimination of generation from the lower Snake River facilities and a desire to have the same level of north to south transfers on the COI/PDCI, the flow across the cutplanes would need to increase. In other words, the generation from the lower Snake River facilities would be replaced with generation from Chief Joseph, Grand Coulee, and other northern and eastern powerplants. However, with this increase in generation, capacities across these cutplanes would be exceeded. Thus, the cutplane flows would need to be limited, which in turn would cause a reduction in the COI/PDCI transfer capability. To increase cutplane capability an improvement to the Schulz-Hanford transmission line and facilities would be required. The estimated costs are $50 to $75 million.

Montana to Northwest Transfer Capability

Capability west of Hatwai would be reduced about 500 MW if the lower Snake River dams were breached. This means that transfers from Montana and/or Western Montana Hydro would need to be reduced to maintain the Hatwai limit. Previous studies have shown that these problems would be mitigated with a Bell-Ashe 500-kilovolt (kV) line from Spokane to the Tri-Cities area. This line would require a new transmission corridor and cost between $100 million to $150 million.

Summer Load Service

The Tri-Cities load area (south of Spokane and Central Washington) would be negatively affected by dam breaching. Specific transmission impacts would be different depending on the location of replacement generation. These include the new Schultz-Hanford line ($50 to $75 million) and reconductoring or rebuilding various other lower voltage lines at an estimated cost of $10 to 20 million. Additional voltage support would also be needed in the Tri Cities area if the four lower Snake River dams were breached. Converting the generators at a hydropower plant to synchronous condensers would be an effective way to produce reactive support required to fix this voltage support problem for Tri-Cities area loads. This could be accomplished with converting the generators at Ice Harbor. Preliminary cost estimates for this conversion are $2 to $6 million.

3.1.7.2 Winter Impacts

The impacts to the transmission system under extreme winter load conditions in the Pacific Northwest were examined. An extreme cold winter load condition was examined since stress on the system is high under extreme weather. The extreme cold winter load level is an abnormal cold condition (arctic express) with minimum temperatures that have a 5 percent probability of occurring. The extreme cold winter load level is approximately 12 percent higher than the expected normal winter peak that has a 50 percent probability of occurring. This is the criteria BPA customers have agreed to in the past.

It was found that imports from the California interties could not meet the shortfall created by the loss of the lower Snake River dams. The import capability today on the COI/PDCI with the dams in place is around 2,400 MW during extreme winter load conditions. This 2,400 MW capability is needed today, with the four lower Snake River dams in place, to augment available generation and spinning reserve requirements in the Pacific Northwest. Without the four lower Snake River dams, either more intertie or more local generation would be required to meet system loads and maintain system reliability. The possible solutions examined were to develop replacement generation or to improve the COI/PDCI. The analysis shows that replacement generation would be about half as costly as intertie transmission improvements.

Pacific Northwest Replacement Generation

With the breaching of the lower Snake River dams it was found that 1,550 MW of new generating resources (replacement generation) strategically located in the Pacific Northwest would be sufficient to meet the winter extreme conditions if the COI/PDCI were not improved. This is about 510 MW more replacement generation than would be required for energy alone.

The new capacity assumed to be built in the future to replace energy lost under Alternative 4, Dam Breaching, was described in Table 3.1-12. The net economic costs identified in this technical report for Alternative 4, Dam Breaching, were based on adding 890 MW of new Pacific Northwest generating resources by year 2010 and 1,040 MW by year 2018. But this takes care of only regional energy losses at the breached dams. The winter transmission impacts of breaching could be mitigated if 1,550 MW of replacement generating resources were in place at the time of breaching of the lower Snake River dams (2007). The transmission system impacts of breaching would require more generation in place sooner (1,550 MW in 2006 versus 890 MW in 2010 and 1,040 in 2018).

The costs of providing additional replacement generation were examined using the system production cost approach as computed by the BPA model. The replacement capacity assumed to be built elsewhere in this analysis was 1,040 MW through year 2018 as shown in Table 3.1-12. To maintain the same transmission reliability an additional 510 MW (1,550 – 1,040) of generation capacity would need to be constructed in Pacific Northwest. Based on the CC construction costs of $601,000 per MW, the additional construction costs of replacement thermal would be about $306 million. These increased costs will be somewhat offset by the expected reduction in system variable costs from adding more generation than is required for energy alone. The annual equivalent economic costs associated with the additional generation capacity are $8.9 million at the 6.875 percent discount rate.

Improvements to COI/PDCI

The alternative solution to building new replacement capacity is intertie transmission system reinforcements. The improvements needed to meet load service requirements for extreme winter conditions include: a second Captain Jack-Meridian 500-kV line (a cross-Cascades line from Klamath Falls to Medford) and a second Big Eddy-Ostrander 500-kV line (a cross-Cascades line from The Dalles to Portland. Both of these new line additions would need to be on a separate right of way from the existing lines due to reliability reasons. The construction costs for a second Captain Jack Meridian line are estimated at $80 to $130 million. The addition of a second Big Eddy-Ostrander line would cost from $70 to $120 million. The average annual costs of these two lines, considering O&M, replacements, repair, and computed at 6.875 percent, were $5.6 to $9.0 million for Captain Jack Meridian and $4.9 to $8.3 million for Big Eddy-Ostrander. The mitigation costs of the transmission solution would be about twice as expensive as the generation solution.

Winter Local Load Service Limitations

There would also be wintertime load service limitations in the Tri-Cities area for extreme cold winter conditions if the lower Snake River dams were breached. A new 230/115-kV transformer in the Franklin area would be required. The estimated cost for adding this transformer is between $15 million and $25 million.

3.1.7.3 Summary of Transmission Impacts

Table 3.1-19 provides the possible solutions and related annual costs based on the 6.875 percent discount rate. The table is broken into the impact areas and possible solutions. For each impact the lowest cost solution is recommended and included in the total economic effects.

Table 3.1-19 shows the range of construction costs as estimated by BPA. Also shown are the incremental O&M costs that would occur if the transmission improvements were built. To develop the annual costs associated with these measures a 45-year replacement cycle was assumed. As can be seen from this table the annual costs associated with improvements needed to maintain transmission reliability with the breaching of the four lower Snake River dams would about $22 to $28 million at 6.875 percent.

Identical summaries were made at 4.75 percent and 0.0 percent discounts rates. The annual costs were $19 to $24 million at 4.75 percent and $16 to $18 million at 0 percent discount rates.

3.1.8 Ancillary Services Effects

This section discusses the ancillary services and the estimated economic values of these services provided by the four lower Snake River facilities. These ancillary services are in addition to the energy, capacity, and transmission support benefits discussed elsewhere in this appendix. With the open access transmission ruling of the FERC, power suppliers are now charging for many of the ancillary services that in the past were generally provided without charge by the entities owning the transmission facilities. In 1998 BPA began to sell these ancillary services. Since these services are a necessary element of a safe and reliability power system, the loss of these services represents economic costs that must be accounted in this analysis.

The basis for the reserve cost and Automatic Generation Control (AGC) assumptions associated with dam breaching were largely based on expert judgement from knowledgeable staff at BPA. The Duty Scheduling office was consulted for the seasonal MW amounts for which the lower Snake River plants are currently relied upon. For simplification it was assumed that this usage would continue into the future, and no effort was made to determine the absolute capability of the lower Snake facilities to provide AGC or operating reserves. Should the restrictions on the Columbia River hydropower projects increase relative to the lower Snake River facilities it is quite likely that the MWs of AGC and operating reserves from the lower Snake River facilities would increase. The converse is also true, but to a lesser degree since the lower Snake River facilities are generally low priorities for ancillary services in the current operating environment. The ancillary service prices were developed using Trading Floor knowledge of the bilateral market for Ancillary Services in the Northwest and market data from the California Independent System Operator (ISO) that was available at the time of the report.

The lower Snake River hydropower plants are used for Automatic Generation Control (AGC). Small but very frequent changes in generation are necessary to perform this function. Hydroelectric facilities, with stored water as their fuel, are extremely flexible and very useful for this purpose. If the four dams were breached, their contribution to this system would have to be spread over the remaining projects or replaced from other sources. To value the AGC, the BPA staff that deals with market sales of ancillary services was consulted. The economic value of AGC that would be lost with the breaching of the lower Snake River dams was based on the percent of time that AGC is utilized, the MW magnitude, and the market value. The average annual value was estimated to be $465,000.

The four lower Snake River dams are also used to provide part of the required reserves for the Federal power system. The WSCC has established reserve requirements for all utilities. These contingency reserves are expected to be "on-call" in the event of emergency loss of generating resources in the system. Utilities are required to have both operating and spinning reserves. The spinning reserve units must be synchronized with the power system and provide immediate response, while the operating reserves must be available within 10 minutes. BPA estimates that the Snake River facilities are used for reserves for about one half of the months of December and March and all of the months of January, February, April, May, and June. BPA relies on about 300 MW of reserves from these four facilities. The market values of these reserve services vary throughout the year. In the high demand winter months it was assumed that BPA would have to purchase reserves from the market at a value of $31/MW-month. During the rest of the year it was assumed BPA would sell this reserve at the average monthly market prices. The annual net economic cost associated with the loss of these reserves is estimated to be $7,183,000.

The total ancillary annual losses for Alternative 4, Dam Breaching are the combination of the AGC loss in Table 3.1-20 and the loss of reserve value in Table 3.1-21. This loss is $7,648,000, annually. This was rounded to $8 million for reporting purposes in the rest of this document.

Table 3.1-19. Hydropower Analysis: Transmission Impacts With Alternative 4, Dam Breaching

Annual Values Based on 6.875%

Timing/ Location of Impacts	Impact Description	Possible Solutions	Estimated Construction Costs ($millions)	Incremental O&M Costs ($millions)	Total Annual Costs ($millions)	Selected Solution Avg. Annual Costs ($millions)
Summer: NW to California	Transfer limit is reduced (a cutplane problem)	Limit COI/PDCI transfer capability from 7200 MW to 7000 MW	Not qualified			
		Upgrade the COI/PDCI	65 to 85	0.3	5.1 to 5.9	
		Site thermal replacement plants to reduce impact	Not quantified			Proper siting 1550 MW for winter could solve this problem
Summer: Upper/Mid Columbia Load Service	Thermal overloads	New Schultz-Hanford transmission line	50 to 75	0.17	3.6 to 5.2	3.6 to 5.2
Summer Tri-Cities Service	Voltage support to the Tri-Cities	Ice Harbor generators converted to synchronous condensers	2 to 6	0.2	0.4 to 0.6	0.4 to 0.6
	Load service impacted	Local line transmission improvements	10 to 20	0	0.7 to 1.4	0.7 to 1.4
Summer: Montana transfer to Northwest	Transfer limit is reduced by 500 MW	New Bell-Ashe transmission line	100 to 150	0.38	7.2 to 10.5	7.2 to 10.5
Summer: Canada Transfer to Northwest	Increased congestion on I-5 transmission corridor	No solution offered	Not quantified			

Table 3.1-19. Hydropower Analysis: Transmission Impacts With Alternative 4, Dam Breaching, Continued

Timing/ Location of Impacts	Impact Description	Possible Solutions	Estimated Construction Costs ($millions)	Incremental O&M Costs ($millions)	Total Annual Costs ($millions)	Selected Solution Avg. Annual Costs ($millions)
			Annual Values Based on 6.875%			
Winter: Meeting extreme winter loads	Import capability is reduced and results in inability to meet extreme loads	Site 1550 MW of replacement generation	306 capital costs for generation	Included in annual costs	8.9	8.9
		New transmission lines – Capt. Jack – Meridian and – Big Eddy – Ostrander	80 to 130 70 to 120	0.2 0.2	5.6 to 9.0 4.9 to 8.3	
Winter: Tri-Cities Load Service	Load Service Limitations	Local transmission improvements McNary - Franklin	15 to 20	0.1	1.1 to 1.5	1.1 to 1.5
Totals 1/			483 to 577			21.9 to 28.1

1/ Includes only costs for selected solutions.

3.1.9 Summary of Hydropower Net Economic Effects

This section combines all the net economic effects as defined by the medium projection conditions. These represent the most likely point estimates of economic effects. However, because of the uncertainty embedded into many of the key variables, a risk and uncertainty analysis was undertaken to provide range of results.

With Alternative 4, Dam Breaching, there would be some savings to the nation because it would no longer incur the costs to operate these dams. This section does not include the savings in operation and maintenance costs that will occur with this alternative. These savings are included in the Avoided Cost category which is discussed in section 3.8.5 and including them here would have resulted in double-counting these costs.

Table 3.1-20. Automatic Generation Control Losses

Month	Hours Per Month	MW Provided	Percent of Time (%)	Value Per Hour (1998 Real $)	Monthly Value ($)
Jan	744	30	20	9.50	42,408
Feb	672	30	20	9.50	38,304
Mar	744	30	20	8.50	37,944
Apr	720	30	20	5.00	21,600
May	744	30	20	5.00	22,320
Jun	720	30	20	6.50	28,080
Jul	744	30	20	9.50	42,408
Aug	744	30	20	16.50	73,656
Sep	720	30	20	11.50	49,680
Oct	744	30	20	6.50	29,016
Nov	720	30	20	8.50	36,720
Dec	744	30	20	9.50	42,408
Annual (Rounded)	8760	30	20		465,000

Table 3.1-21. Lost Annual Reserve Values

Month	Heavy Load Hours	MW Provided	Purchase Percent of time (%)	Market Sale Percent of time (%)	Purchase Cost (1998 Real $)	Market Value Per Hour (1998 Real $)	Monthly Value ($)
Dec 1/2	24	300	25	75	31.00	8.00	1,023,000
Jan	49	300	25	75	31.00	8.00	2,046,000
Feb	44	300	25	75	31.00	8.00	1,848,000
Mar 1/2	24	300	0	100	31.00	7.00	520,800
Apr	48	300	0	100	31.00	3.50	504,000
May	49	300	0	100	31.00	3.50	520,800
Jun	48	300	0	100	31.00	5.00	720,000
Annual (Rounded)	2,648	300					7,183,000

Table 3.1-22 presents the medium results for the two key approaches used to identify the net increases in costs to the power system as compared to the base condition. The costs in the table are the average annual equivalents with different discount rates. The two approaches used in the study were the system production costs and the market pricing approach. Different estimates of net economic costs were made by each of these approaches and models. But, the range of results from minimum to maximum is relatively small. The range is also relatively small over the three discount rates. For example, the annual net costs for Alternative 4, Dam Breaching, at 6-7/8 percent is from $220 to $226 million. The results for this alternative range from $216 to $226 million over all three discount rates.

The costs shown in Table 3.1-22 do not include the costs that would be incurred to maintain the same degree of reliability in the transmission system and the values for the loss of ancillary services. As shown in Tables 3.1-19, the region will have to build additional facilities at an average annual cost of $21.9 to $28.1 million (at 6.875 percent), $19.4 to $24.2 million (at 4.75 percent), and $15.6 to $17.9 million (at 0.0 percent). The ancillary services lost with Alternative 4, Dam Breaching, were estimated in section 3.1.8 as $8 million per year. Table 3.1-23 presents the total range of effects with the medium forecast conditions at the three different discount rates.

In summary, it can be seen from Table 3.1-23 that the total economic effects associated with changes in hydropower production with the different lower Snake River alternatives cover a wide range. With Alternative 2, Maximum Transport of Salmon, and Alternative 3, Major System Improvements, the net economic costs are negative, which is actually a benefit to the nation. The total net economic costs for these two alternatives range from -$7 million to -$10 million, annually, at the 6.875 percent discount rate. The range of net economic costs is larger for Alternative 4, Dam Breaching, and represent a loss to the nation. The net economic costs for Alternative 4, Dam Breaching, range from $251 million to $291 million, annually, at the 6.875 percent discount rate.

Table 3.1-22. Hydropower Analysis: Summary of System Costs (Production Costs and Market Prices)

		Discount Rate 6.875%			
Alternative	**Production Costs**	**Market Price**		**Range of Costs:**	
	BPA Model	**HYDROSIM**	**HYSSR**	**Minimum**	**Maximum**
2 and 3	(9)	(7)	(10)	(10)	(7)
4	255	221	225	221	255
		Discount Rate 4.75%			
Alternative	**Production Costs**	**Market Price**		**Range of Costs:**	
	BPA Model	**HYDROSIM**	**HYSSR**	**Minimum**	**Maximum**
2 and 3	(9)	(7)	(10)	(10)	(7)
4	256	220	224	220	256
		Discount Rate 0%			
Alternative	**Production Costs**	**Market Price**		**Range of Costs:**	
	BPA Model	**HYDROSIM**	**HYSSR**	**Minimum**	**Maximum**
2 and 3	(9)	(7)	(9)	(9)	(7)
4	260	217	221	217	260

Note: Cost differences from Alternative 1, Existing Conditions. Medium projections, 1998 $ million, average of all water conditions. Various in-service dates, 100-year analysis.

Table 3.1-23. Hydropower Analysis: Total Average Annual Net Economic Effects Differences from Alternative 1, Existing Conditions

Alternative	System Costs ($)		Transmission Reliability Costs ($)		Ancillary Services Costs ($)	Total Effects ($)	
	Minimum	Maximum	Minimum	Maximum		Minimum	Maximum
Discount Rate 6.875%							
2 and 3	(10)	(7)	0	0	0	(10)	(7)
4	221	255	22	28	8	251	291
Discount Rate 4.75%							
2 and 3	(10)	(7)	0	0	0	(10)	(7)
4	220	256	19	24	8	247	288
Discount Rate 0%							
2 and 3	(9)	(7)	0	0	0	(9)	(7)
4	217	260	16	18	8	241	286

Note: Medium projections, 1998 $ million, average of all water conditions. Various in-service dates, 100-year analysis.

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3.2 Recreation Use

An important aspect of this economic analysis is the evaluation of outdoor recreation associated with the lower Snake River. The economic values associated with recreation can be separated into direct and indirect economic values. Direct values represent the recreator's willingness to pay for activity. This is measured in two ways: (1) the costs to participate (e.g., the entrance fee); and (2) the dollar amount that the visitor is willing to pay above the out-of-pocket costs — the consumer surplus. Indirect values measure the effects on local economies associated with recreation-related expenditures. The economies of communities located near recreation use areas may depend directly on the number of visitors and the amount of money they spend in the area. Recreation-related expenditures include lodging and food, as well as automobile, boat, fishing, and hunting supplies. This section discusses the results of the analysis used to estimate the direct economic effects of the proposed alternatives in terms of expected recreation activities and the economic value of these activities. Indirect economic effects associated with recreation activities are evaluated in Section 6, Regional Economic Analysis.

3.2.1 Methods

A measure of the direct economic value of goods and services, including recreation activity, is the willingness-to-pay (WTP) of the users. For goods that are sold in a market, the WTP is the amount actually paid to obtain the good plus an additional amount that an individual would have been willing to pay for the chosen quantity of the good. This additional amount is generally referred to as the consumer surplus and represents the value of the quantity of the goods over and above the amount actually paid. Increases in consumer surplus are considered as welfare gains to the consumer because this extra value is obtained without charge. Total consumer welfare to society is measured by summing the consumer surplus across all participants. In the case of valuing recreation, the amount charged for the activity is generally small or non-existent. Since there is no well-established market for the exchange of recreation goods, non-market approaches have to be employed to develop demand curves to estimate consumer surplus.

3.2.1.1 Techniques Used to Measure Visitor Benefits

The structure of this analysis is based on the WRC guidelines (WRC, 1993). These guidelines recommend that either the Travel Cost Method (TCM) or the Contingent Valuation Method (CVM) be used to quantify visitors' net WTP. Both of these methods are used by other Federal agencies and are frequently used by economists (Loomis and Walsh, 1997). In this study, TCM is applied to estimate net WTP for the current reservoir recreation, river recreation above Lewiston, Idaho, and in recreation the Snake River basin in central Idaho. TCM uses the actual number of trips taken by an individual as the quantity variable and the visitor's travel cost as the price variable to trace out a statistical demand curve for recreation using multiple regression. The net WTP is calculated from this demand curve. See AEI (1999a, 1999b, 1999c) for more details on the TCM demand models used.

Since natural river conditions do not exist in the lower Snake River, one cannot survey existing users and directly apply a standard TCM to estimate the value of river recreation with dam removal. Therefore, a hybrid TCM approach, known as "contingent behavior" (CB), is used to estimate the value of river recreation under Alternative 4, Dam Breaching. This hybrid approach involves (a) describing the new recreation conditions, e.g., natural river scenario; (b) asking whether individuals would visit and, if so, how many times per year; (c) and calculating the distance, travel cost, and

travel time to the most likely spot on the river they would visit. Thus, the variables are similar to those used in the TCM for current reservoir recreation. The same general recreation evaluation approach is applied to the data for all alternatives. The contingent behavior approach is widely used in economics, was applied in the Columbia River System Operation Review (SOR) (Callaway, et al., 1995) and has proved to be reliable (Loomis, 1993). A discussion of the contingent behavior TCM is provided in the Drawdown Regional Economic Workgroup (DREW) Recreation Workgroup report (DREW Recreation Workgroup, 1999).

3.2.2 Surveys and Findings

Five recreation use surveys were conducted as part of this study by the DREW Recreation Workgroup. Four of these surveys were designed to identify and value current recreation use. These surveys targeted different stretches of the river and different types of recreation activity. Two separate surveys, an angler survey and a general recreation survey, were mailed to a sample of recreationists who visited the lower Snake River reservoirs from May to October 1997. A survey was also mailed to a sample of anglers who fished the 30-mile stretch of the Snake River above Lewiston, Idaho from September 1997 to March 1998. An angler survey was also distributed to anglers in Central Idaho. The findings of these surveys are summarized in Table 3.2-1 and briefly discussed in the following sections.

Table 3.2-1. Existing Recreation Surveys, Number of Trips, and Annual Benefits

Survey	Number of Completed Surveys	Response Rate (%)	Number of Trips[1/]	Willingness-to-Pay per Trip[1/]	Annual Benefits (000s of dollars)
Reservoir Angler [2/]	537	59	57,388	29.23	1,676
Reservoir General Recreation (excludes Angling) [3/]	408	65	442,834	71.31	31,578
Upriver Angler [4/]	247	72	11,437	35.71	408
Central Idaho Angling [5/]	257	na	129,026	37.68	4,862
Total	**1,449**	**na**	**640,685**	**na**	**38,524**

1/ The number of trips and the willingness-to-pay per trip were estimated based on each survey. The surveys asked how many trips each individual takes a year and how much each trip costs. This travel cost is used to compute an individual's willingness to pay for recreation. Annual benefits are calculated by multiplying the number of trips by the willingness to pay per trip.

2/ Reservoir Angler Survey: Two separate travel cost method mail survey instruments were developed, an angler survey and a general recreation survey.

3/ Reservoir General Recreation Survey: A stratified sample of households received an eight-page survey.

4/ Upriver Angler Survey: Anglers surveyed were generally fishing for steelhead in the 30-mile stretch of the Snake River, above the town of Lewiston, Idaho.

5/ Central Idaho Angling Survey: Surveys were distributed to anglers and rafters at a variety of points by using on-site contacts and guides.

Source: DREW Recreation Workgroup, 1999.

The DREW Recreation Workgroup also surveyed a much larger sample of Washington, Idaho, Oregon, western Montana, and California residents to identify the type and number of recreation users that would visit the lower Snake River if the dams were breached. A stratified sample of households was mailed an eight-page survey. The sample region was based on an evaluation of the

origin of current visitors to the Snake River and guidance provided by DREW. A total of 4,780 completed surveys were returned for a response rate of 54 percent. Only a portion of the 4,780 households returning surveys indicated they would visit the lower Snake River in its natural river condition. A copy of this survey instrument is presented in the DREW Recreation Workgroup report. The survey findings were then applied to all Washington, Idaho, Oregon, western Montana, and California residents. Response rates varied by region. The response rate in the area surrounding the lower Snake River was 56 percent, while the response rate for California was just 28 percent. Two of the natural river visitor use estimates adjust for these response rates when generalizing from the sample to the population to minimize any sample selection bias in the visitor use estimate.

The survey instrument was constructed to determine which types of recreation users would visit the area under a drawdown scenario. The survey further asked the visitors how many times per year those recreation visitors would visit the site. The Corps believes that because responses of one visit per year or more for some of the distant travelers does not appear reasonable, the survey may bias the results and over estimate usage. Those individuals coming from outside the region may not visit annually. Individuals from outside the region may only visit once every 5 years, or once every 10 years or once in a lifetime. Therefore, the Corps believes this may tend to over-estimate the recreation usage estimates of those from outside the region. This may be considered an unresolved issue at this time.

3.2.2.1 Lower Snake River Reservoir

The average net WTP per trip of reservoir fishing was $29.23 (many of these are very short trips of a day or less). Using information on angler hours per day and angler days per year from the Normandeau et al., survey, it is estimated 2,831 anglers took 57,338 angler trips during 1997. Multiplying the value per trip times the estimated number of trips yields annual benefits of $1.676 million in 1997.

The average net WTP or net benefit per day of non-angling reservoir recreation such as boating and waterskiing was $71.31 per trip. Corps visitation data are used to estimate the total number of hours. Subtracting the estimate of angler hours obtained from the Normandeau et al. data yields hours of reservoir recreation. Using the AEI survey data on average length of stay allows an estimate of days, which can be converted to trips. Annual recreation benefits are calculated by multiplying the value per trip times an estimated 442,834 trips yields an annual recreation benefit of $31.578 million. Details of the per-trip and annual TCM benefits methodology for general reservoir recreation analyses can be found in AEI (1999a), while the reservoir fishing is detailed in Normandeau, et al. (1999).

These benefits per trip can be compared to the benefit estimate recreation travel cost method demand model used to evaluate Lower Granite Reservoir recreation for the SOR study. Callaway et al. (1995) estimated an average consumer surplus of $32.74 per day. This value is greater than the reservoir angling estimate, but lower than the general reservoir recreation value, even when adjusted to a per trip basis.

3.2.2.2 Upriver of Lewiston, Idaho

The average net WTP for anglers fishing in the 30-mile stretch of the Snake River above Lewiston, Idaho is $35.71 per trip. Angler use estimates were made using a combination of aerial surveys, ground-based counts, and the visitor intercept surveys. Multiplying the benefit per trip times the

resulting estimate of 11,437 angler trips yields an annual value of $408,408. Details of the per trip and annual benefits of this upriver angler analysis can be found in Normandeau et al. (1999).

3.2.2.3 Central Idaho

Anglers in Central Idaho (Snake River Basin) had an average net WTP per trip of $37.68. This yields an annual benefit of $4,861,700 when multiplied by an estimated 129,026 steelhead trips (see AEI, 1999b). The average net WTP per trip for non-angling upriver recreation such as rafting is $87.24. Using survey data information, the estimated use is 180,000 non-angler visitors to the region (AEI, 1999c). It is estimated these visitors take 497,480 trips annually. Multiplying the trip value times the estimated number of trips yields an annual value of $43,400,000.

3.2.2.4 Natural River General Recreation

Using the contingent behavior TCM, the value per trip of salmon and steelhead fishing in what would be the free-flowing lower Snake River if the dams are breached has an estimated value of $256 per trip of 3.36 days or $76 per day. The value for mainstem free-flowing river recreation activities such as rafting, canoeing, kayaking, and swimming, as well as river-related recreation, is estimated at $297 per trip of 2.6 days using survey respondents' reported trip cost (this is consistent with how the mainstem river anadromous fishing TCM benefits are calculated above). In the tables and analysis below, this river recreation value of $114 per day is considered the high NED value. Using a definition of the cost-per-mile price variable in the TCM demand function consistent with AEI (1999a), reservoir recreation yields a value of $71.36 per trip of 2.6 days. This resulting value per day is more consistent with the literature on the value of non-boating types of river-related recreation activities respondents indicated in the survey. A similar definition of the price variable consistent with AEI (1999a) reservoir angler travel cost per mile is used with the contingent behavior TCM to estimate the value of salmon fishing in the reservoirs ($39 per day) with the non-drawdown alternatives. For the mainstem river anadromous fishing, this $39 per day is considered the low NED value, while the $76 per day is considered the high NED value. The high NED value is more consistent with the value of salmon and steelhead river fishing in the literature than in Walsh et al. (1992).

Four estimates of river recreation demand and benefits are provided. They range from a low estimate (using just households that indicated they would definitely visit with dam breaching and assuming zero visitation from survey non-respondents) to a high estimate based on households that indicated they definitely *or* probably would visit and assuming that survey non-respondents would visit at the same rate as survey respondents. Middle use estimates of demand are provided by assuming that households that did not respond to the survey would visit at the same rate as households that did respond to the survey, but applying this assumption only to the fraction of the population that would definitely visit. A middle-high demand estimate consists of households that indicated they definitely *or* probably would visit, but assumes that survey non-respondents would not visit. Thus both the low and middle-high estimates explicitly adjust for potential concerns over low response rates from more distant areas by using zero visits for non-respondents. This yields a very conservative low and middle-high visitor estimate. Alternatively, the middle- and high-use estimates are not corrected for sample selection effects and they may yield over-estimates of recreation use.

These demand estimates are also phased in over time as the natural river system recovers from dam breaching. Table 3.2-2 presents the expected suitability of the area for river recreation with dam breaching. This table was initially developed by recreation planners at the Corps and then refined and applied to the dam breaching survey data. As can be seen in this table, some activities recover slower than others. For example, river and shorebased recreation takes up to two decades to fully recover.

Table 3.2-2. Recreation Suitability Recovery after Dam Breaching

Activity	Year 1	Year 5	Year 10	Year 20
Jet Boating and Jet Skiing	0.2	0.5	0.7	1
Rafting/Kayaking/Canoeing	0.3	0.5	0.8	1
Swimming	0.2	0.4	1	1
Picnicking and Primitive Camping	0.8	1	1	1
Developed Camping	0.6	0.9	1	1
Hiking and Mountain Biking	0.8	1	1	1
Hunting	0.5	0.8	1	1

Further, the demand estimates are compared to availability of developed campgrounds, dispersed camping areas, and boat-ramp capacity to determine how much of the demand can be accommodated given the recreation facilities after dam breaching. The visitation estimates for general river recreation, presented in Table 3.2-3, reflect the application of these capacity constraints to the demand estimates. In particular, three key capacities were examined: boat ramps, developed campsites, and areas available for primitive camping. Corps recreation planners provided information on the number of boat ramps, developed campsites, and suitable areas for primitive camping. To calculate visitor day capacities, we took the recreation season as April through October. This time coincides with spring break through the steelhead fishing season, as well as summer vacations. This area is attractive in spring and fall, due to the early warm temperatures. While rather hot during the summer, the area receives high use during the vacation months of July and August. Given the average party size of three persons, the maximum number of visitor days that could be accommodated between April and October was calculated with the current number of developed campsites. This figure initially limited the amount of developed camping demand that could be accommodated in all scenarios during the first decade. By the end of the first decade, the river areas would have sufficiently stabilized and the number of developed campsites probably would have more than doubled, fully meeting the demand with the low estimate. More than doubling developed campsites would accommodate about 75 percent of the demand in the middle- and high-use estimates. This would probably coincide with the percentage of developed camping demand met in many popular areas. Primitive camping and primitive camping would be limited during the first few years until the receding beaches became suitable for camping and picnicking. Boat ramp capacity would be sufficient for all use scenarios, although they would be used at close to capacity in the middle-high and high-use estimates. The use estimates presented in Table 3.2-3 reflect the assumption that non-fishing river recreation use would not have to be limited to protect the anadromous fishery.

Table 3.2-3. Number and Distribution of River Trips and Benefits in Year 10

	Percentage	River Recreation Trips	Annual Low NED[1/] ($, Millions)	Annual High NED[1/] ($, Millions)
Low Estimate				
Rural ID,OR,WA	19.50	47,823	3.41	14.20
Rest of Pacific NW	50.10	122,920	8.77	36.51
California	30.40	74,595	5.32	22.15
Total	**100.00**	**245,338**	**17.50**	**72.86**
Middle Estimate				
Rural ID,OR,WA	14.41	66,617	4.75	19.79
Rest of Pacific NW	40.66	188,014	13.42	55.84
California	44.94	207,824	14.83	61.72
Total	**100.00**	**462,456**	**33.00**	**137.35**
Middle-High Estimate				
Rural ID,OR,WA	16.87	128,633	9.18	38.20
Rest of Pacific NW	39.61	295,557	21.09	87.78
California	43.52	331,841	23.68	98.56
Total	**100.00**	**756,031**	**53.95**	**224.54**
High Estimate				
Rural ID,OR,WA	11.45	200,989	14.34	59.69
Rest of Pacific NW	29.51	518,201	36.98	153.91
California	59.04	1,037,003	74.00	307.99
Total	**100.00**	**1,756,193**	**125.32**	**521.59**

1/ The low NED values are consistent with literature for general recreation, while the high NED values are consistent with literature for river angling.

Unlike current conditions, the contingent behavior surveys predict that a large percentage of total river recreation trips would originate in distant areas such as Portland, Seattle, and California with the addition of 140 miles of free-flowing river. Three of the four visitor estimate scenarios indicated that 30 to 45 percent of the total trips would be from California, depending on the sample expansion assumptions. This percentage of trips is not out of line because California represented 60 to 70 percent of the population of the sampling area. Table 3.2-3 illustrates the distribution of trips for each of the three sampling areas with the high and low NED values.

This change in distribution of the origin of visitors with the free-flowing river is consistent with the pattern found in AEI's travel cost analyses of actual visitation. Specifically, the current reservoirs are primarily local-use areas with most of visitors coming from within 100 to 120 miles

(Normandeau et al., 1999; AEI. 1999a). However, in the free-flowing river sections of central Idaho, 21 percent of the river visitors come from 1,000 miles or more away, with 12 percent coming from 1,500 miles or further (AEI. 1999b, 1999c). This pattern is consistent with the lack of availability of substitute rivers of the size and magnitude of the lower Snake River with the dams breached. Thus, people are willing to travel greater distances to visit free-flowing rivers. Besides the limited number of major rivers in the western U.S., many existing rivers such as the Rogue, Salmon, or Colorado have use limits, and permits are rationed by lottery. By contrast, reservoir visitors do not have to travel great distances as there are numerous reservoirs in the local area, including Lake Wallula downstream from Ice Harbor Dam very near the Tri-Cities area, Dworshak Reservoir near Lewiston, Idaho, and three large lakes near Spokane, Washington.

Salmon and Steelhead Fishing

As explained in more detail below, salmon and steelhead fishing demand with dam breaching would be constrained by species availability. The availability of salmon for harvest was estimated by the interagency PATH biologists as extended by the DREW Anadromous Fish Workgroup (1999). The limited availability of salmon for recreational fishing would constrain the angler trips to an annual average of about 500 trips during the first 5 years and an annual average of about 14,000 angler trips over the remaining period of analysis. This would be about 6 percent of the low estimate of salmon angler demand. The same pattern is evident for steelhead, where numbers of fish available for recreational harvest would limit anglers to an annual average of 100,000 days on the mainstem of the lower Snake River over the period of analysis. This represents 50 percent of the lowest estimated demand. As explained in more detail in the next section, a portion of the resident fishing angler demand also would be supplied with Alternative 4, Dam Breaching.

3.2.3 Application of Survey Results to EIS Alternatives

Several different alternatives are evaluated in the EIS. However, from the standpoint of general/non-fishing recreation, these alternatives can be grouped into two main categories: alternatives in which the dams remain (Alternative 1, Existing Conditions, Alternative 2, Maximum Transport of Salmon, and Alternative 3, Major System Improvements) and dam breaching (Alternative 4, Dam Breaching).

3.2.3.1 River Recreation

For Alternative 4, Dam Breaching, the estimated time path of river recovery following dam removal and its influence on recreation suitability and facility availability was estimated by Corps recreation staff. In Table 3.2-2, recreation carrying-capacity estimates by time interval were refined and used to estimate the percentage of the different recreation activities that could be accommodated in each time period. These percentages were applied to the four different estimates of non-angling river recreation demand calculated from the survey. The resulting visitation figures were reduced by the carrying capacity of the developed campgrounds in all but the lowest estimate of river visitor demand. The resulting visitor days were valued using the benefits calculated from the TCM, as described above. In particular, the high NED value scales the TCM demand curve based on the visitor survey responses. The low NED value scales the TCM demand curve based on cost per mile of reservoir visitors as used in the reservoir recreation valuation model of AEI.

3.2.3.2 Recreational Fishing

The estimates of salmon and steelhead that could be recreationally harvested with each alternative were provided by the DREW Anadromous Fish Workgroup. These estimates were based on the preliminary PATH analysis and additional assumptions were made to extend the PATH findings to all Snake River stocks. The workgroup also used information from various international and national fishery treaties to allocate the total stocks to commercial, tribal, and recreational catches. The biological availability of salmon and steelhead for recreational harvest was used to constrain the river angler demand calculated from the household survey data. Specifically, only the proportion of river angler demand compatible with salmon and steelhead available for recreational harvest was counted in any given year. This resulted in only a small fraction of the angler demand indicated in the survey being met.

Details of Resident and Steelhead Fishing Calculation Procedures

Using the Anadromous Fish Workgroup's generalization of PATH estimates of salmon and steelhead with existing reservoirs (Alternative 1, Existing Conditions and Alternative 3, Major System Improvements), the time path of anadromous fishing benefits was calculated for these three alternatives. The changes in salmon and steelhead available for recreational harvest reflected fisheries improvements recently put in place (Alternative 1, Existing Conditions) or proposed improvements with Alternative 2, Maximum Transport of Juvenile Salmon and Alternative 3, Major System Improvements. To estimate the number of angler resident fish trips and steelhead fishing trips, current reservoir fishing trips and fishing trips in the free-flowing stretch above Lewiston were tabulated. These trips were separated into resident fish species and steelhead trips based on information from the Normandeau et al. (1999) analysis. Generally Normandeau and Bennett concluded that there would be minor effects on resident fish for the non-drawdown alternatives (e.g., Alternative 1, Existing Conditions through Alternative 3, Major System Improvements). With Alternative 1, Existing Conditions through Alternative 3, Major System Improvements, resident trips and their value probably would continue into the future. The remaining steelhead trips were related to baseline steelhead harvest figures to calculate trips per steelhead harvested. This factor was applied to future estimates of steelhead harvests provided by DREW Anadromous Fish Workgroup (based on preliminary PATH data) to calculate future steelhead fishing trips. The mainstem resident and steelhead fishing use and benefits are the sum of the resident fishing and the estimated future steelhead fishing.

To estimate the effect of Alternative 4, Dam Breaching, on mainstem resident fish, information on acres of habitat quantity and productivity per hectare (ha) was used (Normandeau and Bennett, 1999). With dam breaching, the surface area of habitat would fall from 13,715.3 to 5,326.7 ha (33,890 to 13,162 acres). However, estimated biomass would increase from 50.9 to 84.7 kg/ha with natural river conditions. If the two effects were combined, there would be a net loss, as the loss in habitat area would be greater than the gained productivity. Based on these two factors, the loss would be about a one-third reduction in resident fish carrying capacity with dam breaching. Thus the estimated resident fishing benefits with Alternative 4, Dam Breaching would be two-thirds of estimated current resident angler trips and benefits.

To estimate the mainstem river steelhead fishing days with Alternative 4, Dam Breaching, two sources of information were used: the hours needed to harvest a steelhead and the conversion of angler hours to angler days. Since this was the same information used in formulating the baseline steelhead catch rate in the contingent behavior survey, the same number was used, 24 hours to harvest one steelhead (Idaho Department of Fish and Game). The average steelhead angler in the free-flowing section of the lower

Snake River fishes 7.2 hours per day (Normandeau et al.. 1999). To estimate the benefits of steelhead fishing in the free flowing mainstem of the lower Snake River. the contingent behavior TCM was used (DREW Anadromous Fish Workgroup, 1999). This study yielded a low and high value per day ($39 and $76, respectively) based on whether the demand curve is scaled by the average cost per mile of reservoir anglers McKean used in his work with Normandeau et al. (1999). or whether the survey reported costs of anglers who would use the free-flowing mainstem lower Snake River.

To estimate the number of steelhead fishing days in the tributaries. a process similar to that described above was used, except for some tributary-specific information. The DREW Anadromous Fish Workgroup estimated recreational steelhead harvests in the tributaries for each alternative. Trips per steelhead in year zero were calculated by using current steelhead fishing trips (129,026 trips) in central Idaho tributaries of the Snake River, as estimated by AEI (1999b), divided by the year zero was calculated recreational steelhead harvest. This steelhead-per-trip figure was then applied to the DREW Anadromous Fish Group's estimate of the number of steelhead over the 100-year period of analysis.

Details of Salmon Fishing Calculations

To estimate days of salmon fishing in the mainstem of the Snake River with all alternatives, the estimate used was 35 hours to recreationally harvest one salmon. This information was obtained from the special recreational salmon fishing season on the Hanford reach of the Columbia River. It was used as the low salmon fishing catch rate baseline in the contingent behavior recreation survey. This figure was applied to the DREW Anadromous Fish Workgroup's estimate of recreational harvest allocation for spring/summer and fall chinook salmon with each alternative in each time period to estimate total hours of salmon fishing. As with steelhead, the average length of a fishing day was calculated as 7.2 hours on the mainstem of the lower Snake River. The estimate of salmon fishing benefits came from the contingent behavior survey performed by the DREW Recreation Workgroup (1999), described above. With Alternative 1, Existing Conditions through Alternative 3, Major System Improvements, mainstem lower Snake River salmon fishing would take place in a reservoir setting. Therefore, the salmon fishing value per day applied came from the demand curve scaled by the reservoir anglers' cost per mile obtained from the reservoir fishing analysis. This value was $39 per day for salmon fishing. This was also the low value for the free-flowing river under Alternative 4, Dam Breaching. The high value for Alternative 4, Dam Breaching reflected scaling the demand curve by the reported costs of anglers who said they would come to fish the free-flowing lower Snake River ($76 per day).

To estimate salmon angler days in the tributaries, the same basic approach was used, in particular, the same 35 hours per salmon harvested. The average length of a fishing day was 6.72 hours per the AEI (1999b) survey of central Idaho rivers.

3.2.3.3 Calculation of Present and Annualized Value of Recreation Benefits

Annual values projected over the 100-year study period were used to calculate the present and annualized value of recreation. When using a positive discount rate, the timing of when the different recreation benefits were received would influence the present or annualized value of recreation under each alternative. The time profile of benefits would differ among the alternatives. Alternative 1, Existing Conditions currently provides non-fishing reservoir recreation benefits; these would probably continue each year into the future. However, future fishing benefits would be influenced by recent actions taken to enhance steelhead and salmon populations. The fishery

recreation benefits of Alternative 1, Existing Conditions, therefore, would differ slightly from simply extrapolating the current annual benefits. The future recreational fishing benefits for Alternative 1, Existing Conditions were divided by using PATH estimates of steelhead and salmon fishing benefits. Alternatives involving major system improvements or dam breaching would require several years to deliver some of their benefits and several decades for the salmon fishing benefits to be fully realized.

To compare relative worth today, the present worth or present value was calculated using two positive discount rates. These are 4.75 percent (the rate used by BPA) and 6.875 percent, the discount rate used by the Corps for Fiscal Year 1999. This discount rate would weight benefits (and costs) in the near future more heavily than those obtained in the distant future. For purposes of comparison, the tribal discount rate of zero is presented in Table 3.2-4. This would weight all benefits and costs equally over time. The present value of recreation benefits over the 100-year period was converted into average annual equivalent values. The ranking of the proposed alternatives is the same using the average annual or present values.

3.2.4 Summary of Recreation Results

Tables 3.2-4 through 3.2-6 display the average annual equivalent value of the recreation benefits of each of the EIS alternatives at the three different discount rates, respectively. Each table calculates the benefits of Alternative 4, Dam Breaching at a low NED value per day and a high NED value. The low NED value is based on scaling the river recreation and river fishing demand curve using the cost per mile of reservoir visitors. The high NED estimate is based on scaling the demand curve using the costs of visitors to the free-flowing section as reported in the DREW Recreation Workgroup (1999) contingent behavior survey. Overall benefit estimates are presented using the middle-use estimate for river recreation (this uses only those visitors who said they would definitely visit and applies this visitation rate to all households in the region). This middle-use estimate is bracketed by the low-use estimate. This estimate also relies upon the visitation rate of only those individuals stating they would definitely visit, but it conservatively assumes no visitation from households that did not return the survey. Finally, an upper bound is calculated by applying the visitation rate of households that would definitely and would probably visit to all households in the region.

While there has been some debate about the difficulty in predicting anadromous fish populations, as is evident from Tables 3.2-4 to 3.2-7, recreational anadromous fishing is not the majority of the total benefits. In part, this is due to the small allocation of available salmon and steelhead to recreational fishing, as compared to commercial fishing. All four alternatives would have increasing fishing benefits over time, although PATH estimates for Alternative 4, Dam Breaching show the largest salmon and steelhead gains.

Much of the overall gain in recreation benefits of Alternative 4, Dam Breaching over Alternative 1, Existing Conditions through Alternative 3, Major System Improvements would be due to the gain in river recreation days and the value of these days being substantially higher than the loss in recreation activities that could only be undertaken in a reservoir (e.g., waterskiing, etc.). A small part of the gain of the Alternative 4, Dam Breaching high-NED fishing was driven by survey respondents' reported desire to fish for anadromous fish in a free-flowing river environment as compared to a reservoir.

Table 3.2-4. Annualized (AAEV) Value of Recreation Benefits over 100 Years in Millions of 1998 Dollars @ Zero Percent (Tribal Rate)

	1 ($)	2 ($)	3 ($)	4[1/] (Low NED) ($)	4[1/] (High NED) ($)
Reservoir Recreation	31.6	31.6	31.6		
River Recreation					
Low Use Est				44.0	182.6
Middle Use Est				99.4	412.6
High Use Est				441.5	1832.0
Recreational Fishing					
Resident and Steelhead	2.86	2.89	2.88	5.05	8.95
Mainstem Salmon	.55	.73	.68	1.50	2.93
Steelhead-Tributaries	26.35	27.5	27.34	35.42	68.79
Salmon-Tributaries	.27	.33	.31	.81	1.58
Total Middle Use Est	**61.63**	**63.05**	**62.81**	**142.18**	**494.85**
Total Low Use Est				**86.78**	**264.85**
Total High Use Est				**484.28**	**71914.25**

1/ The low NED values are consistent with literature for general recreation, while the high NED values are consistent with literature for river angling.

Table 3.2-5. Annualized (AAEV) Value of Recreation Benefits over 100 Years in Millions of 1998 Dollars @ 6.875 Percent (Corps rate)

	1 ($)	2 ($)	3 ($)	4[1/] (Low NED) ($)	4[1/] (High NED) ($)
Reservoir Recreation	31.6	31.6	31.6		
River Recreation					
Low Use Est				36.18	150.12
Middle Use Est				80.85	335.53
High Use Est				367.18	1523.74
Recreational Fishing					
Resident and Steelhead	2.32	2.35	2.35	3.25	5.44
Mainstem Salmon	.26	.36	.34	.62	1.20
Steelhead Tributaries	19.21	21.07	21.15	24.51	47.61
Salmon Tributaries	.164	.20	.19	.32	.62
Total Middle Use Est	**53.55**	**55.58**	**55.63**	**109.55**	**390.40**
Total Low Use Est				**64.88**	**204.99**
Total High Use Est				**395.88**	**1578.61**

1/ The low NED values are consistent with literature for general recreation, while the high NED values are consistent with literature for river angling.

Table 3.2-6. Annualized (AAEV) Value of Recreation Benefits over 100 Years in Millions of 1998 Dollars @ 4.75 Percent (BPA Rate)

	1 ($)	2 ($)	3 ($)	4[1/] (Low NED) ($)	4[1/] (High NED) ($)
Reservoir Recreation	31.6	31.6	31.6		
River Recreation					
Low Use Est				38.1	158.3
Middle Use Est				85.5	354.9
High Use Est				385.3	1599.1
Recreational Fishing					
Resident & Steelhead	2.43	2.46	2.45	3.64	6.21
Mainstem Salmon	.33	.45	.42	.82	1.60
Steelhead-Tributaries	20.75	22.55	22.58	27.04	52.52
Salmon-Tributaries	19	.23	.22	.42	.81
Total Middle	**55.3**	**57.24**	**57.27**	**117.42**	**416.04**
Total Low				**70.02**	**219.44**
Total High				**417.22**	**1660.24**

1/ The low NED values are consistent with literature for general recreation, while the high NED values are consistent with literature for river angling.

Table 3.2-7. Difference in Annualized AAEV Value of Recreation Benefits from Alternative 1, Existing Conditions Millions of 1998 Dollars @ 6.875 Percent (Corps rate)

	2 ($)	3 ($)	4[1/] (Low NED) ($)	4[1/] (High NED) ($)
Reservoir Recreation	0	0	-31.6	-31.6
River Recreation				
Low Use Est			+36.18	+150.12
Middle Use Est			+80.85	+335.53
High Use Est			+367.18	+1523.74
Recreational Fishing				
Resident and Steelhead	.03	.03	.93	3.12
Mainstem Salmon	.10	.08	.36	.94
Steelhead-Tributaries	1.86	1.94	5.30	28.40
Salmon-Tributaries	.04	.03	.16	.46
Total Middle Use	**2.03**	**2.08**	**56.0**	**336.85**
Total Low Use Est		**11.33**	**151.44**	
Total High Use Est		**342.33**	**1525.06**	

1/ The low NED values are consistent with literature for general recreation, while the high NED values are consistent with literature for river angling.

Table 3.2-7 illustrates the net effect of Alternative 2, Maximum Transport of Salmon, Alternative 3, Major System Improvements, and Alternative 4, Dam Breaching as compared to Alternative 1, Existing Conditions, calculated at the Corps discount rate of 6.875 percent. Specifically, Table 3.2-7 shows the gain or loss in recreation benefits of each alternative compared to the current baseline

(Alternative 1, Existing Conditions), which is used as the future. Based on the PATH fish estimates (as extended from the PATH stocks to all stocks by the DREW Anadromous Fish Workgroup), there would be small gains to salmon and steelhead fishing with Alternative 2, Maximum Transport of Salmon and Alternative 3, Major System Improvements, as compared to Alternative 1, Existing Conditions. The gains in fishing benefits with the Alternative 4, Dam Breaching high-NED value would be significant, amounting to over $30 million, enough to offset the lost reservoir recreation. In addition, there would be large net gains overall due to river recreation with Alternative 4, Dam Breaching, ranging from $11.33 to $1525 million annually, with central estimates between $56 and $342 million annually.

Given that the figures in the low NED column are consistent with literature for general recreation, and that the figures in the high NED column are consistent with literature for river angling, the most likely estimates due to river recreation with Alternative 4, Dam Breaching must be a composite of portions from both the low and the high NED columns presented in Table 3.2-7. This composite would result in the most likely estimate of a benefit of an annual value of $82 million for Alternative 4, Dam Breaching.

3.2.5 Risk and Uncertainty

As in any survey and statistical analysis, there is a degree of uncertainty regarding the exact magnitude of the estimates of visitor use and recreation benefits. This section expands upon the potential range of river-visitor use estimates and provides a range of benefits per trip associated with the various recreation uses.

Reservoir recreation benefits represent three-fourths of the benefits of Alternative 1, Existing Conditions, Alternative 2, Maximum Transport of Salmon, and Alternative 3, Major System Improvements. The reservoir value per trip from AEI (1999a) is $71.31. The 95 percent confidence interval around the mean would be $47 to $148 per trip. Using the 95 percent confidence interval, the annual value of recreation would change from the mean estimate of $31.6 million to a low of $20.8 million to a high of $65.5 million annually.

River recreation benefits also reflect a large portion of the benefits for Alternative 4, Dam Breaching. The mean benefit per trip using the low NED value would be $71.36, with a 95 percent confidence interval of $39 to $446 per trip. Using the visitors' entire reported trip costs as the price variable in the demand function, river recreation benefits would have a mean value of $297 per trip, with a 95 percent confidence interval of $181 to $831 per trip.

The low and middle estimates in all of the tables in this chapter used just those people indicating that they would definitely visit. Based on the research by Champ et al. (1997), respondents who were sure of their responses had criterion validity with actual cash payments. Since it is likely that at least some of the respondents indicating they would probably visit the lower Snake River if the dams were breached might visit, the low and middle estimates are conservative due to the omission of the "probably visit" respondents. Further, the low estimate reduces the "definitely yes" visitation estimate by the survey non-response rate. That is, the low estimate assumes that none of the non-respondents to the survey would visit the lower Snake River if the dams were breached. Thus, the low estimate is doubly conservative.

3.2.5.1 Avoided Cost Analysis

Breaching the dams in Alternative 4, Dam Breaching would not result in reduction of any significant recreation management costs for the Corps. Most of the Corps recreation maintenance cost is related to the developed campground areas and other developed facilities that would remain under all alternatives. The labor costs associated with rangers would continue as well.

Mitigation

The reservoir recreation effects from breaching the dams in Alternative 4, Dam Breaching would not be directly mitigated. Much of the same water-based recreation probably would continue as today, with the major exception being activities such as waterskiing. The availability of existing nearby reservoirs such as Lake Wallula downstream from Ice Harbor Dam and near Tri-Cities, Dworshak Reservoir near Lewiston, Idaho, and three large lakes near Spokane (Rufus Woods Lake, Coeur d'Alene, and Lake Pend Oreille) would continue to provide opportunities for flat-water recreation.

3.2.6 Conclusion

Table 3.2-7 presents the net changes for each alternative from the base case. Alternative 2, Maximum Transport of Salmon and Alternative 3, Major System Improvements would both provide benefits of approximately $2 million annually.

Table 3.2-7 also presents the net changes for Alternative 4, Dam Breaching. However, these benefits are presented as a range with low and high NED values. The low NED values are consistent with literature for general recreation, while the high NED values are consistent with literature for river angling. Therefore, the Corps believes that the most likely estimate of the net changes for Alternative 4, Dam Breaching, would be a composite of portions from both the low and high NED columns presented in Table 3.2-7. This composite would result in the most likely estimate of a benefit of an annual value of $82 million for Alternative 4, Dam Breaching.

3.2.7 Unresolved Issues

The survey instrument was constructed to determine which types of recreation users would visit the area under a drawdown scenario. The survey further asked the visitors how many times per year they would visit the site. Because responses of less than once per year did not appear to be reasonable, the survey might bias the results and over-estimate usage. Those individuals coming from outside the region might not visit annually. Individuals from outside the region might visit only once every 5 years, once every 10 years, or once in a lifetime. This might result in over-estimating the recreation use by those outside the region. This issue will be further investigated for the final report.

Additionally, a discrepancy was noted during the final stages of this analysis; while the analysis assumed increased benefits from added capacity, the increased costs to create the facilities were not added. This has the effect of understating NED costs and RED short-term benefits (from new construction). RED benefits are addressed in Section 6, Regional Analysis. This issue should be resolved between the draft and final reports.

3.3 Transportation

The four alternatives being evaluated in this Feasibility Study/EIS are Alternative 1. Existing Conditions. Alternative 2, Maximum Transport of Juvenile Salmon. Alternative 3. Major System Improvements. and Alternative 4, Dam Breaching. There would be no change to existing navigation facilities on the lower Snake River under the first three alternatives. Commercial navigation on the lower Snake River would. however. no longer be possible under Alternative 4. Dam Breaching. The following sections present a summary of the effects of dam breaching on the transport of commodities that are now shipped from ports on the lower Snake River. These alternatives are, as a result. represented by the base case in the following discussion.

The following sections address the methodology employed in this analysis, transportation system costs with and without dam breaching, including infrastructure requirements. and uncertainties surrounding the analysis. Details of the analysis are contained in the full-length report developed as part of this feasibility study (DREW Transportation Workgroup, 1999).

3.3.1 Methodology

The methodological approach and analysis of commodity transportation costs is based in part upon analytical techniques that were employed in System Operation Review (SOR) studies performed during 1992-93. The SOR study evaluated a variety of alternative system operating scenarios for the Columbia-Snake River System (CSRS) and quantified the economic effects of each scenario applying national economic development (NED) criteria. This evaluation of breaching the four lower Snake River reservoirs and the resulting economic effects on the existing transportation system uses the same general approach as the SOR and builds upon the methodology and data developed for that study.

The direct economic costs that would result from breaching the four lower Snake River dams are measured and expressed as changes in the NED account. NED costs represent the opportunity costs of resource use, measured from a national rather than a regional perspective. In the case of dam breaching, the change in the cost of transporting products and commodities now shipped from ports on the Snake River is an NED cost, but the loss of revenue and profit by barge companies is not. Only the costs of resources actually used are included in the NED analysis. Although market prices often reflect total opportunity cost of resources, this is not always the case, and surrogate costs must sometimes be used to adjust or replace market prices (or published or contract rates). In this study, for example, it was judged appropriate to use modal costs computed through analysis of the actual fixed and variable costs of each transportation mode—barge, rail, and truck.

The transportation system impacts that would occur under Alternative 4, Dam Breaching, were estimated using a transportation system model that was designed specifically to track and estimate the cost of transporting commodities that now move on the Snake River. Modeling information requirements and assumptions are summarized in the following sections.

3.3.1.1 Modeling Requirements

Measuring the direct economic effects of dam breaching on commercial navigation activity involved evaluating alternative shipping modes and costs, and identifying the most probable combination of storage, handling, and transport modes that would emerge in response to cessation of waterborne transport on the lower Snake River. Specific information required for this analysis included 1) establishment of base and projected future commodity shipments, 2) identification of commodity origins and destinations

with and without dam breaching, 3) estimates of modal costs and storage and handling costs at throughput facilities, 4) assessment of regional rail and truck capacity, and 5) assessment of a variety of other elements that characterize the regional transportation system. A brief description of how these data were derived and a description of the procedures and assumptions applied in the evaluation process are presented in the following paragraphs.

Base and Projected Future Commodity Shipments

Projections of future commodity shipments were developed through analysis of waterborne commerce data for the CSRS for the decades of the 1980s and 1990s. The analysis included assessments of exports, the volume of shipments on the Snake River, and the types of commodities shipped. Forecasts of future shipments were developed for each of eight commodity groups and later combined into five groups for the transportation system cost analysis.

Commodity Origins and Destinations

The study area considered in this analysis encompasses grain producing areas as well as origins and destinations for non-grain commodity groups that use the CSRS. Origins of grain transported by barge on the lower Snake River, derived from previous studies conducted in 1992 for the SOR and updated for this study, include areas within northeastern Oregon, eastern Washington, Idaho, Montana, and North Dakota. Origins or destinations for non-grain commodity groups in the lower Snake River region (such as petroleum or fertilizers) also generally fall within this area. The origins of non-grain commodities, which are relatively insignificant in terms of the overall volume of Snake River shipments, were taken directly from data developed for the SOR.

Commodity Growth Forecasts

The basis for commodity growth forecasts is the volume of grain and non-grain shipments that originate from the Snake River above Ice Harbor Dam. These forecasts were based on forecasts originally developed for the Columbia River Channel Deepening Feasibility Study, in conjunction with an analysis of historical data and anticipated trends in the volume of relevant commodities now moving on the lower Snake River. Projections were made at 5-year intervals from 1997 to 2017 for the various commodity groups moving on the lower Snake River segment of the CSRS. Due to the degree of uncertainty inherent in long-range forecasting, projected volumes were assumed to remain level beyond 2017.

Transportation System Cost Estimating Procedures

A Microsoft ACCESS database was developed to estimate transportation-related costs associated with the base condition and the dam-breaching scenario. The database was used to quantify the costs (transportation, storage, and handling) of shipping commodities under existing conditions and in the absence of commercial navigation on the lower Snake River. The results of these two analyses were then compared to determine the effect that river closure would have on transportation system costs. This comparison is simply the difference between transportation costs with dam breaching versus transportation costs without dam breaching.

The model is not an optimization model. It is simply a database of existing and alternative routings of grain and non-grain commodity movements from origins to destinations. Transportation costs under the base case

are based on existing routings. Most likely alternative routings are used in the dam breaching case. At least two alternative routings for commodities from each origin are included in the database. and the model is designed to select the lowest-cost routing. Storage and handling costs associated with each alternative routing are added to the transportation cost to determine the total cost associated with each routing. The model accumulates transportation, storage, handling, and total costs for the lowest-cost routings and compiles summary reports on movements and costs by state. county or region. and mode of transportation. In addition. miles (bushel-miles for grain) and ton-miles (for non-grain) are similarly compiled and reported.

Modal Cost Estimating Procedures

Modal costs for barge, rail, and truck were developed using transportation analysis models (TAMs) for each mode. The models used were developed and copyrighted by Reebie Associates, Transportation Management Consultants. The specific models used are briefly described below:

- **Barge Cost Analysis Model (BCAM).** The BCAM is designed to facilitate the analysis of barge-load shipments on the nation's inland waterways. All of the inland waterways on which commercial barge-load shipments are made are built into the model. The model includes data about the river systems, locks and dams, barges, towboats, and commodities. The user operating the model specifies shipment characteristics, cost factors, operating factors, and, routing.

- **Rail Cost Analysis Model (RCAM).** The RCAM is an enhanced personal computer application of the Interstate Commerce Commission's Uniform Rail Costing System (URCS) methodology. The URCS is a complex set of procedures that transforms annually reported railroad expense and activity data into estimates of the costs of providing specific services. It is based an analysis of cause and effect relationships between the production of railroad output ("service units" such as car miles or gross ton miles) and the associated expenses defined by the model's accounting system. These relationships define a series of "unit costs," for example, crew costs per train mile, that are applied to the service units generated by a shipment to produce the estimated cost of providing the service.

- **Truck Cost Analysis Model (TCAM).** The TCAM is used to determine the underlying cost and revenue requirements for truck shipments. The TCAM data input process is divided into three sections: primary shipment specifications (11 variables), driver and utilization factors (10 variables), and detailed costing factors (25 variables). Default values are built into the model for all input variables.

3.3.1.2 Modeling Assumptions

Grain Storage and Handling Costs and Assumptions

Storage costs are a function of two factors, the duration of storage and the monthly cost. The duration of storage is a function of the relationship between harvest and demand. Thus, the duration of storage in the model is the same with and without dam breaching. Differences in costs between the two cases are due to the difference in the cost of storage at the various types of elevators. Elevator storage costs at country and river elevators were reviewed for this study. The review revealed that monthly storage costs at country elevators are about $0.006 per bushel higher than storage costs at river elevators. Thus, the difference in storage cost is due to use of country elevator storage with dam breaching, rather than the cheaper river

elevator storage. Storage costs are incurred at all elevator types, with the exception of export terminals. A cost for on-farm storage is not estimated because it would be the same with and without dam breaching.

Handling costs are a function of the number of times grain is required to transfer to a different mode of transportation or to go into or out of storage. The types of movements included in the model are as follows:

Base Case:

- Farm-to-river-to-export terminal
- Farm-to-country elevator-to-river-to-export terminal

Note: The model does not include any farm-to-rail-to-river movements, even though these types of movements have been reported for ports in the Lewiston area and the Port of Wallula.

With Dam Breaching:

- Farm-to-alt river-to-export terminal
- Farm-to-country elevator-to-alt river-to-export terminal
- Farm-to-railhead-to-export terminal
- Farm-to-country elevator-to-railhead-to-export terminal

Storage and handling costs are assumed to be the same for all country elevators, including those with unit-train loading facilties. Handling costs at the export terminals were assumed to be the same for both rail and barge grain deliveries.

Capacity Assumptions

Two general assumptions about capacity are fundamental to the analysis and the construction of the transportation system model. The first assumption is that the current system is in equilibrium in terms of storage, handling, and transport mode capacity. On the basis of this assumption, it was unnecessary to model capacity in the base case. The second assumption is that with dam breaching, modal, handling, and storage capacity can be expanded on a regional basis to meet geographic shifts in demand without significant increases in long-run marginal and average costs. The Economic Procedures and Guidelines the Corps uses to determine project benefits and costs reason that if inland navigation capacity is reduced, competing surface transport modes either possess or would add the capacity necessary to accommodate additional traffic. Similarly, it is assumed that grain elevator throughput capacity could be increased with little impact upon long-run marginal and average costs or unit costs. Therefore, modeling capacity for the dam-breaching scenario was unnecessary for the NED analysis. Specific assessments of capacity infrastructure improvements were, however, made and are discussed in Section 3.3.5. Storage and handling costs for non-grain commodities were assumed to be generally equivalent under either scenario.

Seasonality of Shipments

Shipments of both grain and non-grain commodities experience some month-to-month or season-to-season fluctuations in volume. On a year-to-year basis, many of these fluctuations are due to fluctuations in market conditions rather than the underpinning demand factors. Grain exports from the lower Columbia River may, for example, vary significantly from one month to the next because of market conditions while the demand for grain remains relatively constant. These types of monthly fluctuation are not built into the model used for this analysis. Instead, the model was constructed and operates based on the implicit assumption that volumes of shipments of both grain and non-grain commodities are uniform from month to month.

Alternative Routings

For the base case analysis, the model is designed to replicate a non-optimized base condition based on projected future commodity movements under existing conditions. For the dam-breaching scenario, the model evaluates transportation, storage, and handling costs associated with the shift of projected future volumes of commodities to alternative modes of transportation and routings. The model includes at least two alternative routings for commodities from each origin. In general, alternative routings developed for the SOR were used. These alternative routings were, however, reviewed and updated to take into account changes in unit-train rail loading facilities at country elevators. Alternative rail origins for grain were limited to those having a car-loading capacity of at least 25 cars. This requirement was imposed because for rail transport to be feasible a minimum unit-train loading capability of 25 to 26 cars is needed. This requirement reduced the number of country elevators identified in the base case as having rail access from over 100 to 14. Those facilities that were eliminated are those with a loading capacity of fewer than 25 cars. In addition, facilities within 15 miles of a facility included in the model were excluded on the basis that costs associated with these facilities would be the same as for those already in the model.

Construction of the model further assumes that as grain or other commodity transport is impaired by dam breaching, shipments would be rerouted by motor carriers to river elevators located on the McNary Pool and transshipped by barge, or would be shipped by rail directly to lower Columbia export elevators. The model includes unit costs for transportation, storage, and handling associated with each of the alternative routings for each origin-destination pair affected by waterway closure. Distances between origins and destinations were identified and are included in the model. The overall method employs the assumption that current and projected levels of exports from the region would continue to be maintained.

Adjustment of Model Results

A fundamental assumption made for this analysis is that the existing transportation of grain represents the least-cost condition. Therefore, it was assumed that the cost of all movements of grain with dam breaching should be at least as costly as under the base condition. Actual operation of the model, however, showed that this was not the case. The model results showed that a number of grain movements were found to be less costly with dam breaching than with the existing transportation system. Since this conflicts with the assumption that the existing system is the least-cost system, the model includes a check that identifies whether the cost of a movement is less with dam breaching than under the base condition. If the cost with dam breaching is less, the difference is calculated and added to the transportation costs with dam breaching. The adjustments computed, however, are not tracked in the model by movement, etc., but are simply summed and added to total transportation costs with dam breaching. The use of this type of adjustment is somewhat unconventional, opposed by the IEAB, and is an unresolved issue at this time.

Taxes, Subsidies, and Price Level Changes

The analysis does not take into consideration the effects of taxes or subsidies, which represent transfer payments within the national economy. The effects of potential changes in relative prices are also not considered.

Effects on the Quantity of Land in Grain Production

In the short term, it is possible that some marginal land now used for production of grain could become unprofitable and be taken out of production. The actual impact on individual operators would depend on a number of factors, including the productivity of the land, the fixed cost of land, in the form of capital and interest payments and taxes, and, the actual increase in transportation costs. For most farms, however, the increase in transportation costs would simply mean that the return to fixed capital (such as land) would be reduced. Some land may go out of production in the short term, assuming that grain production is the highest and best use of the land currently used for this purpose. In the long run, however, the reduced economic return to land that would result from higher transportation costs would be reflected in a reduced value of land and the land would continue to be used for grain production. This analysis is, therefore, based on the assumption that implementation of dam breaching would have no effect on the amount land used for grain production. The effects of increased transportation costs on grain producers are discussed in more detail in Section 6 of this appendix.

Period of Analysis, Price Level, and Interest (Discount) Rates

The initial year of dam-breaching implementation is assumed to be 2007, and NED effects are measured over the 100-year period, 2007 to 2106. For purposes of comparison with other fish restoration measures being evaluated in the feasibility study, annual economic costs were adjusted to a base year, 2005.

Uncertainty

A considerable amount of uncertainty exists about modal rate behavior, infrastructure and capacity requirements, the potential for lost grain sales to export markets, and the overall transportation-related financial impacts associated with dam breaching. These issues and the sensitivity of the analysis to alternative assumptions are addressed later in this section.

3.3.2 Navigation Facilities

The Columbia-Snake Inland Waterway is a 465-mile-long water highway formed by the eight mainstem dams and lock facilities on the lower Columbia and Snake rivers. The waterway provides inland waterborne navigation up and down the river from Lewiston, Idaho, to the Pacific Ocean. This system is used for commodity shipments from inland areas of the Northwest and as far to the east as North Dakota. The navigation system consists of two segments: the downstream portion, which provides a deep-draft shipping channel, and the upstream portion, which is a shallow-draft channel with a series of navigation locks.

The deep-draft portion of the navigation system consists of a 40-foot-deep by 600-foot-wide channel that extends up the Columbia River from the Columbia Bar (River Mile [RM] 3.0) to Vancouver, Washington (RM 105.6). Major import-export terminals are located adjacent to the channel at the Columbia River ports of Vancouver, Longview, and Kalama in Washington, and Portland and Astoria in Oregon.

The shallow draft portion of the waterway is a Federally maintained channel and system of locks that extends from Vancouver, Washington, to Lewiston, Idaho. The channel extends up the Columbia River from Vancouver, Washington (RM 106), to Richland, Washington (RM 345), and from the mouth of the Snake River (Columbia River RM 325) to Lewiston, Idaho (Snake River RM 141). This channel has a minimum authorized depth of 14 feet at the minimum operating pool (MOP) elevations of each of the upstream dams.

The presence of the Columbia-Snake River Inland Waterway has led to the development of a sizable river-based transportation industry in the region. Riverside facilities managed by port districts and various other public and private entities are located on the pools created by the system of dams and locks. Fifty-four port and other shipping operations provide transportation facilities for agricultural, timber, and other products. There are 22 port facilities located along the shallow draft portion of the waterway, including nine on the lower Snake River. All of the ports on the lower Snake River have grain-handling capability.

3.3.3 Waterborne Commerce

3.3.3.1 Columbia River Deep-Draft Channel

The Columbia River serves an extensive region that covers much of the western United States. Within the region, a variety of commodities, foodstuffs, and other products are produced. Of those industries within the region that generate waterborne commerce, agriculture predominates, particularly with respect to the production of grains such as wheat and barley. In addition, corn, which is produced outside of the region, represents a significant volume of shipments from export terminals on the lower Columbia River. Other regional industries that use water to transport products include aluminum, pulp and paper, petroleum products, and logs and wood products. In terms of volume, wheat and corn represent the major share of total commodities shipped on the deep draft segment of the Columbia River channel. Other products include autos, containerized products, logs, petroleum, chemicals, and other miscellaneous products. Countries involved in the region's export trade are Japan, Korea, and Taiwan, as well as other Pacific Rim countries.

3.3.3.2 Columbia-Snake Inland Waterway

Products shipped on the shallow draft segment of the river system consist principally of grain, wood products, logs, petroleum, chemicals, and other agricultural products. Bulk shipments make up much of the waterborne traffic on the upstream channel. A number of commodities, principally non-grain agricultural and food products and paper products, are shipped via container. Approximately 97 percent of downriver-bound container shipments are destined for Portland, Oregon, with the remainder going to Vancouver, Washington. Historically, the bulk of upriver barge shipments have been made up of petroleum products.

Analysis of data from the Waterborne Commerce Statistics Center (WCSC) and the Corps' Lock Performance Monitoring System (LPMS) showed that commodities from 37 commodity groups were shipped on the waterway in both 1996 and 1997. These commodity groups were aggregated into five groups for the purposes of this analysis—grain, petroleum products, wood chips and logs, wood products and other. Shipments from 1992 to 1996 are shown in Table 3.3-1.

Table 3.3-1. Tonnage of Shipments by Commodity Group on the Shallow Draft Portion of the Columbia-Snake Inland Waterway from 1992 to 1996

Commodity Group	Thousand Tons				
	1992	1993	1994	1995	1996
Grain	4.612.9	4,902.3	5.671.4	5.883.3	5.710.4
Petroleum Products	1.567.1	1.746.1	1.693.1	2.164.6	2.023.2
Wood Chips and Logs	1.837.3	2.130.8	2.056.4	1.779.2	1.281.9
Wood Products	61.3	44.7	63.1	73.4	28.1
Other	1.224.7	761.9	615.3	626.9	629.6
Total	**9.303.3**	**9.585.8**	**10,099.3**	**10.527.4**	**9.673.2**

Source: Waterborne Commerce Statistics Center (WCSC), New Orleans. LA. and Corps' Lock Performance Monitoring System (LPMS)

3.3.3.3 Lower Snake River

Commodity movement on the lower Snake River is dominated by grain (primarily wheat and barley), which made up 75.8 percent of the tonnage passing through Ice Harbor lock from 1992 to 1997. During the same period, wood products, including wood chips and logs, accounted for 15.8 percent, petroleum products accounted for another 3.0 percent, paper and pulp accounted for 2.3 percent, and all other commodities accounted for the remaining 3.0 percent. Table 3.3-2 provides a summary of the annual tonnage by commodity group passing through Ice Harbor lock from 1992 through 1997.

The Columbia-Snake Inland Waterway from Lower Granite pool through McNary Dam handled cumulative totals of approximately 6.7 million tons in 1990, 7 million tons in 1991, and 6.7 million tons in 1992. This included upbound and downbound cargo originating at Lower Granite, Little Goose, Lower Monumental, Ice Harbor, and McNary reservoirs (Corps and NMFS, 1994). Since 1980, cumulative cargo volumes have ranged from approximately 5 million to 8 million tons per year. Tonnage using at least a portion of the Snake River segment, as measured by data for Ice Harbor, averaged about 3.8 million tons per year from 1980 through 1990. This average increased slightly to about 4 million tons per year from 1992 through 1997 (Table 3.3-2).

Table 3.3-2. Tonnage by Commodity Group Passing through Ice Harbor Lock 1987-1996 (thousand tons)

Commodity Group[1/]	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Average
Grain	2,906	3,981	2,532	3,109	3,241	2,612	2,706	3,135	3,471	2,821	3051.4
Wood Chips and Logs	461	394	320	304	375	500	854	910	857	530	550.5
Petroleum	117	105	115	108	106	108	129	137	144	95	116.4
Wood Products	46	52	45	42	74	61	45	58	68	28	51.9
Other	96	127	203	166	159	80	57	74	82	85	112.9
Total	**3,626**	**4,659**	**3,215**	**3,729**	**3,955**	**3,361**	**3,791**	**4,314**	**4,622**	**3,559**	**3,883**

1/ All figures are rounded to the nearest 1.000

Notes: Large movements of 1.2 million tons in 1988 and 1.4 million tons in 1989 have been omitted because they appear to have been one-time movements and would significantly skew the "All Other" category in which they were classified (see DREW Transportation Group).

Ice Harbor lock was out-of-service from January 1 through March 9, 1996, while the downstream lift gate was being replaced.

Source: Waterborne Commerce Statistics Center (WCSC), New Orleans. LA. and Corps' Lock Performance Monitoring System (LPMS)

3.3.3.4 Projected Growth in Commodity Shipments

The U.S. Army Corps of Engineers. Institute for Water Resources (IWR) developed a forecast of future commodity growth for the major commodity groups that are presently shipped on the lower Snake River. The basis for the forecast was the commodity forecast developed for the Corps' Columbia River Channel Deepening Feasibility Study. Historical data for Snake River shipments were compiled for aggregated commodity groupings for the 10-year period from 1987 through 1996. This data set was used as the basis for projecting future growth as a share of forecast growth for the Columbia River. Projections were initially established at 5-year increments to encompass a 20-year period, 2002 through 2022. As stated earlier, for the dam, breaching option, the implementation date is assumed to be 2007; therefore, the evaluation used projections for the period from 1997 to 2017, with growth held constant thereafter. The rationale and basis for estimating future growth in volume for the respective commodity groups are described below.

Grain

Historic wheat and barley exports from the Lower Columbia are compared with shallow draft wheat and barley shipments from the lower Snake River above Ice Harbor in Table 3.3-3. From 1987 to 1996, shipments on the lower Snake River averaged about 23.4 percent of wheat and barley exports from the lower Columbia River and ranged from a high of 26.5 percent share in 1991 to a low of a 20.2 percent share in 1992. This is a relatively low range, with fluctuations from year to year probably being driven by variations in grain production among the regions. Also shown in the table is the year-to-year change in percent share for the Snake River.

Table 3.3-3. Wheat and Barley Exports From the Lower Columbia Compared With Shipments from the Lower Snake River above Ice Harbor, 1987-1996 (in thousand tons)

Wheat & Barley	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	Avg.
Lower Columbia Exports	12,085	14,945	10,458	11,778	12,233	12,762	13,428	14,908	14,603	13,691	13,089
Snake River Shipments	2906	3981	2532	3109	3241	2612	2706	3135	3471	2821	3,051
Snake River %	24.0	26.6	24.2	26.4	26.5	20.5	20.2	21.0	23.8	20.6	23.38
Change in %	--	2.6	-2.4	2.2	0.1	-6.0	-0.3	0.9	2.7	-3.2	

Source: Waterborne Commerce Statistics Center (WCSC), New Orleans, LA, and Corps' Lock Performance Monitoring System (LPMS)

The average Snake River share of 23.4 percent of exports of wheat and barley from the lower Columbia River is used as the basis for forecasting future wheat and barley movements on the Snake River above Ice Harbor. The forecast was made by applying this percentage to projected exports for wheat and barley developed for the Columbia River channel deepening study. The resulting forecast is summarized in Table 3.3-4.

Table 3.3-4. Waterborne Traffic Projections above Ice Harbor Lock 2002-2022 (in thousand tons)[1]

Commodity Group	Average	2002	2007	2012	2017	2022
Grain	3,019	3,647	3,799	3,798	3,892	4,052
Wood Chips and Logs	716	694	694	694	694	694
Petroleum Products	118	127	136	145	156	167
Wood Products	52	66	79	101	128	148
Other	81	97	110	128	148	167
Total	**3,986**	**4,631**	**4,818**	**4,866**	**5,018**	**5,228**

1/ These projections are the medium or "most likely" values projected in the navigation analysis. The Portland District's analysis also provided low ("likely minimum") and high ("likely maximum") values for each year. The averages are computed across all three values for each year.

Source: Snake River Commodity Projections. IWR Navigation Data Center. Ft. Belvoir. VA.

Wood Chips and Logs

In terms of tons. the next largest commodity group using the Snake River above Ice Harbor, after wheat and barley, is wood chips and logs. Between 1987 and 1996, shipments of wood chips and logs varied from a low of 303,800 tons (1990) to a high of 909,600 tons (1994), with an average of 716,100 tons from 1991 to 1996. Although 1997 data were not available as this report was being compiled, data from the LPMS suggest 1997 wood chips and logs traffic was about 594,000 tons at Lower Granite Dam. Using this information as a proxy for 1997 movements on the Snake River above Ice Harbor, it appears this commodity group recovered some of the traffic lost in 1996, but did not attain the robust traffic levels experienced from 1993 to1995. Adding in the 1997 estimate to the average base traffic calculation reduces this value to 694,200 tons. This is the amount carried forward into the forecast analysis.

With an R-squared of .37, the historic data for 1987 to 1997 do not indicate a clear linear trend that could be used for credible forecasting. The traffic in wood chips and logs appears to vary around an average level, increasing or decreasing with market conditions, but without the prospect of sustained long-term positive growth. This assessment has generally been confirmed in conversations between Portland District and commercial shippers who have reported future traffic expectations as "flat" or stable. For this reason, the forecast for wood chips and logs has been held steady at the adjusted (to include the 1997 estimate) average of 694,200 tons. Since no growth is being forecast for the base traffic, these figures are the same in each forecast year. The forecast is shown in Table 3.3-4.

Petroleum Products

Petroleum products, the third largest commodity group transported on the lower Snake River, generally account for approximately 80 percent of all upriver commodity movements above Ice Harbor lock (Corps and NMFS, 1994). Annual petroleum product shipments ranged from 95,000 tons in 1996 to 144,000 tons in 1995, with an average of 116,000 tons from 1987 through 1996. Conversations with terminal managers indicated that shipments of petroleum by barge tend to decline when excess refinery production in the Great Plains and Rocky Mountain regions further east becomes available by pipeline in the Spokane area. From there, petroleum products can be trucked in competitively. When those supply routes tighten and prices increase, barged petroleum from the Portland area becomes more competitive.

The forecast assumes these competitive supply dynamics will continue in the future, but with a generally upward trend in barge traffic as the demand for petroleum products in the Snake River hinterland increases with general population and economic growth. Historic population data for the Snake River hinterland counties indicates an average annual increase of 1.4 percent since 1980 and 1.7 percent since 1990. Forecast growth is based on the longer-term population growth rate of 1.4 percent. The resulting forecast is shown in Table 3.3-4.

Wood Products and Other

Of the commodity categories being assessed in the present analysis, it was observed that "other farm products" (that is, all farm products other than wheat and barley) and "wood products" (including pulp and waste paper, paper products, and primary wood products) were most likely to be containerized. The forecast referenced above was adapted to the lower Snake River through an analysis of container movements on the Columbia and Snake rivers, with the assumption that the Snake River's share of the total would remain unchanged over the forecast period. The forecast for chemicals, which primarily consist of fertilizer and ammonia, was based on the forecast for grain with the assumption that the ratio of the grain to chemicals ratio would remain constant over time. The resulting forecasts are shown in Table 3.3-4.

Summary

In all, projections were made for eight commodity groups. These groups were then combined into the five groups and were included in the transportation model. The "other" commodity group includes other farm products, chemicals, containers, and all other. The medium or base forecast for each commodity group is shown in Table 3.3-4.

3.3.4 Base Condition Transportation Costs

3.3.4.1 Modeling Considerations

One of the key elements in determining commodity transport costs is identifying origins and destinations of product movements. Within the Columbia River Basin, country elevators located in one county may collect and store grain from sources in several adjacent counties. This means that grain may ultimately be transshipped to river elevators located in other counties. These movements, as such, tend to have a three-dimensional aspect in terms of origins and interim destinations. In order to reduce the complexity of data management, country elevators were considered to be the starting point for the movement of grain down-river, with the exception of those grain shipments made directly from farm to river elevators. This eliminated the need for a three-dimensional approach that would vastly enlarge the magnitude and complexity of the commodity flow data. The effect of this modeling convention on estimated costs is to understate costs by the amount of the cost to move grain from farms to country elevators, however, the overall costs of moving grain from farms to country elevators or other interim holding facilities are unlikely to differ significantly between base and dam breaching conditions. For modeling purposes, therefore, this simplifying assumption was applied except in those cases where grain is transported directly from farm to river elevators, without dam breaching. With dam breaching, modeling was based on the assumption that farm-to-river elevator shipments would now move directly from farms to country elevators with unit train loading capacity. This may not be the case for specific farms because some farm-to-river movements of grain may be determined by the relative location of farms to the river

elevators. The assumption is, however, considered to be valid in general because with dam breaching other farms would be expected to be located near elevators with rail loading capacity.

Modal and Other Costs

The next step in computing transportation costs was to input modal costs for each origin/destination pair. As explained previously, modal costs were developed for the study using models developed and maintained by Reebie Associates. Costs assigned for the base condition, for example, included the cost of the grain movements by truck from country elevators to river elevators within the dam breaching reach, and then the cost to move the grain by barge to export terminals. Storage and handling costs are also included. These latter costs are based on rates charged for these services, rather than on NED-based costs, as is the case with modal costs.

Other Considerations

In the process of evaluating data obtained and applied in this analysis, it was determined that grain from Montana and North Dakota is normally shipped to the CSRS as a backhaul for building materials that are transported to these states and eastward as far as Chicago. Since backhaul shipments are required to only generate sufficient revenue to pay the incremental costs of the shipment, this significantly reduces costs. For this evaluation, it was judged that backhaul shipments of grain by truck from Montana and North Dakota origins to Lewiston would continue in the future. With dam breaching, however, the river destination would shift from Lewiston to the Tri-Cities area. It was further assumed that all long-distance grain movements (in excess of 150 miles) include backhauls. Accordingly, truck movements of grain of 150 miles or more were given a backhaul-based cost.

Storage and handling rates were obtained for each elevator type—country and river. In compiling these data, it was noted that there is a significant variation in rates that are charged. Further analysis indicated that the variation is due largely to market strategies of owners of multiple facilities. It was necessary to make adjustments to some of the raw data to derive the average rates that were used in the model.

3.3.4.2 Transportation Costs — Base Condition

For the base condition, grain transportation, storage, and handling costs were based upon current and projected levels of commodity flows (see Section 3.3.1). Model estimates of the costs displayed in Table 3.3-5 below are for projected grain movements for 2007. Costs are not shown for any of the other years included in the forecast because projected growth in the volume of grain does not have a significant effect on costs at the per bushel or even per ton levels. Total cost (in dollars), cost per bushel (in cents), and cost per ton (in dollars) are shown for each state. Estimates of total costs per bushel range from a high of about $7.10 for Montana to a low of $0.34 for Oregon. These costs are, however, simply estimates as the estimate for Montana clearly suggests. These costs, especially for storage and handling, at nearly $6.50 per bushel, are much higher than actual costs. The DREW Transportation Study Team is aware of this problem, and corrections have been made to the model. These corrections were not made in time to be included in this document, but will be included in the next version. This does not, however, affect the primary objective of the analysis — to estimate the change in costs if dam breaching were to occur — because these costs are the same with and without dam breaching.

Table 3.3-5. Base Condition Grain Shipments and Transportation, Storage, and Handling Costs for 2007 Projected Volume, by State

State	Grain Quantity	Transportation Cost ($)	Storage Cost ($)	Handling Cost ($)	Total Cost ($)
Idaho					
Cost Per Bushel	32,289,941	.347	.147	.215	.709
Cost Per Ton	968,795	11.55	4.91	7.16	23.62
Total Cost		11,193,026	4,758,470	6,932,211	22,883,707
Montana					
Cost Per Bushel	6,537,310	.717	3.065	3.313	7.095
Cost Per Ton	196,139	23.90	102.16	110.41	236.47
Total Cost		4,687,358	20,038,366	21,655,789	46,381,513
North Dakota					
Cost Per Bushel	2,458,172	1.327	0.0	0.0	1.327
Cost Per Ton	73,753	44.23	0.0	0.0	44.23
Total Cost		3,262,017	0	0	3,262,017
Oregon					
Cost Per Bushel	980,218	.339	0.0	0.0	.339
Cost Per Ton	29,409	11.28	0.0	0.0	11.28
Total Cost		331,837	0	0	331,837
Washington					
Cost Per Bushel	84,355,029	.203	.157	.224	.584
Cost Per Ton	2,530,904	6.77	5.24	7.46	19.46
Total Cost		17,127,974	13,258,963	18,868,710	49,255,647
Totals					
Cost Per Bushel	126,620,670	.289	.301	.375	.964
Cost Per Ton	3,799,000	9.63	10.02	12.49	32.14
Total Cost		**36,602,212**	**38,055,799**	**47,456,710**	**122,114,721**

Costs associated with grain transport under the base condition were converted to average annual amounts over the period of analysis from 2007 to 2106. These average annual amounts, that reflect zero, 4.75, and 6.875 percent rates of interest, are presented in 1998 dollars in Table 3.3-6.

Table 3.3-6. Base Condition – Grain, Average Annual Costs, 2007 – 2106 (1998 dollars)

Interest Rate (%)	Average Annual Costs ($)
6.875	126,042,205
4.75	126,963,320
0.00	129,337,780

Non-Grain Commodities

For purposes of analysis, non-grain commodities were combined into four groups: petroleum, logs and woodchips, wood products, and other. The other group is comprised of other farm products, containerized products, and chemicals. For the base condition, transportation costs reflect current and

projected volume. Transportation costs associated with non-grain commodities for selected years under the base condition are presented in Table 3.3-7.

Table 3.3-7. Base Condition Total Annual Transportation Costs for Non-grain Commodities for 2002, 2007, 2012, and 2017 (1998 dollars)

Year/Commodity Group	Base Case ($)
2002	
Petroleum	14.838.745
Logs and Wood Chips	47.879.179
Wood Products	4.380.282
Other	6.125.027
Total	73.223.233
2007	
Petroleum	15.893.106
Logs and Wood Chips	47.879.179
Wood Products	5.242.586
Other	6.946.350
Total	75.961.221
2012	
Petroleum	16.936.369
Logs and Wood Chips	47,879.179
Wood Products	6.703.299
Other	8.084,392
Total	79,603.239
2017	
Petroleum	19,511.230
Logs and Wood Chips	47,879,179
Wood Products	8,494,810
Other	9,345,900
Total	85.231,119

Costs associated with non-grain commodities were converted to average annual amounts over the period of analysis from 2007 to 2106 and are displayed below in Table 3.3-8. These average annual amounts, computed at zero, 4.75, and 6.875 percent rates of interest. are expressed in 1998 dollars.

Table 3.3-8. Base Condition Average Annual Costs for Non-Grain Commodities, 2007-2106 (1998 dollars)

Discount Rate (%)	Average Annual Costs ($)
6.875	82.274,899
4.750	83,006,143
0.000	84.671,628

Base Condition Summary

Transportation costs associated with all commodities under the base condition are presented in Table 3.3-9. They were computed at zero, 4.75, and 6.875 percent rates of interest, expressed in 1998 dollars, and converted to average annual amounts for the period of analysis from 2007 to 2106.

Table 3.3-9. Summary of Base Condition Total Average Annual Costs—All Commodities, 2007-2106 (1998 dollars)

Discount Rate (%)	Average Annual Costs ($)
6.875	208,317,104
4.750	209,969,463
0.000	214,009,408

Adjustment of Annual Costs to the Base Year

Average annual costs in Table 3.3-10 were adjusted to the base year of 2005 to be consistent with analyses of other fish restoration alternatives. This was done by discounting the values from 2007 to 2106 (Table 3.3-9) by 2 years at the appropriate discount rate. The adjusted annual costs are shown in Table 3.3-10.

Table 3.3-10. Annual Costs Adjusted to the Base Year of 2005—All Commodities (1998 dollars)

Discount Rate (%)	Average Annual Costs ($)
6.875	182,377,458
4.750	191,358,639
0.00	214,009,408

3.3.5 Dam Breaching Condition

3.3.5.1 Geographic Scope of Impacts

The geographic scope of this analysis includes all communities, port facilities and terminals that are located adjacent to the lower Snake River and have direct access to the navigation channel. This scope also includes inland areas geographically distant from the CSRS that make significant use of the navigation system. Grain export-elevators on the lower Columbia River are part of the study area but export destinations, such as Pacific Rim nations in Asia as a practical matter, are not. A fundamental premise of the analysis is that with dam breaching, export markets will continue to be supplied with the same reliability as the existing system provides.

The analysis of the economic effects of dam breaching on grain producers is limited to the potential changes in how grain is shipped to export terminals in the Portland area and the associated changes in costs. The analysis and results are general in nature and do not apply directly to specific grain producers.

3.3.5.2 Alternative Transportation Modes And Costs

With loss of access to the Snake River portion of the CSRS, commodities would move by the next least costly available mode, such as rail direct to export elevators on the lower Columbia or by truck to river elevators located on the McNary pool. For the dam-breaching scenario, the evaluation process in most

cases considers the following two alternatives: the use of truck-barge combination to the closest river terminal unimpaired by dam breaching, or truck transport to the closest rail loading facility with multi-car loading facilities. Where rail access is presently available at country elevators, grain would either shift to rail direct from those locations, or be moved by truck to a rail distribution point where unit trains could be assembled. At country elevators where rail is presently the primary means of transport, this would remain the case with dam breaching. As with the base condition, modal costs were prepared for rail, barge, and truck movements using the Reebie models.

3.3.5.3 Alternative Origins

If dam breaching were to occur, grain now shipped via the lower Snake River would shift to alternative modes of transportation. Commodities would either be rerouted via truck to river elevators located on McNary pool or shipped by rail directly to export elevators on the lower Columbia River. To evaluate the transportation, storage, and handling costs associated with this shift, it was necessary to identify alternative origins and intermediate destinations. Alternative destinations were identified through review and revision of the alternative destinations identified in SOR (Corps, 1995). The alternative rail origins (intermediate destinations) of grain shifted from the lower Snake River to rail are shown in Table 3.3-11. Each of these facilities currently has the capability of loading unit trains of 26 or more railcars. The actual number of elevator facilities with unit-train loading capability is significantly greater than the number of facilities included in the model. On the Burlington Northern Santa Fe (BNSF) system, there are actually 39 facilities in eastern Washington and 4 in northern Idaho. These facilities have a combined storage capacity of just slightly less than 53.6 million bushels (bu). For grain now shipped through lower Snake River ports that would continue to be shipped by barge, the alternative barge origin (intermediate destination) is the area close to the confluence of the Snake and Columbia rivers, including the Tri Cities.

Table 3.3-11. Alternative Rail Origins of Grain With Dam Breaching

Origin	County	Capacity (bu)	Railroad
Washington			
Coulee City	Grant	2,038,000	Palouse R. and Coulee City (PCC)
Plymouth	Benton	4,129,000	BNSF
Harrington (2)	Lincoln	2,579,000	BNSF
Odessa (Lamona)	Lincoln	638,000	BNSF
Spangle (3)	Spokane	1,235,000	PCC & BNSF
Spangle	Whitman	3,440,000	PCC & BNSF
Idaho			
Craigmont	Lewis	1,744,000	Camas Prairie RailNet
Grangeville	Idaho	1,552,000	Camas Prairie RailNet
Idaho Falls	Bonneville	Na	Union Pacific
Pocatello	Bannock	Na	Union Pacific
Nampa	Canyon	Na	Union Pacific
Mountain Home	Elmore	Na	Union Pacific
Bliss	Gooding	Na	Union Pacific
Burley	Cassia	Na	Union Pacific
American Falls	Power	Na	Union Pacific
Blackfoot	Bingham	Na	Union Pacific
Oregon			
Pendleton	Umatilla	Na	Union Pacific

Notes: There are multiple facilities at some locations, as indicated by the number in parentheses following the city name. na = not available.

3.3.5.4 Transportation Costs with Dam Breaching

Grain transportation costs under the dam-breaching option were developed based upon the projected commodity flows that would be diverted to alternative modes and alternate intermediate destinations. Estimates of the costs associated with projected grain movements in 2007 are presented in Table 3.3-12. Storage and handling costs of grain movements are also shown. Total cost (in dollars), cost per bushel in cents (cts), and cost per ton (in dollars) are shown for each state. Data are presented for 2007 because this is the year that actual dam breaching would begin, and commodity shipments would be diverted away from the lower Snake River. If dam breaching were to occur, estimated grain transportation costs would range from 40.1 cents per bushel in Oregon to $7.30 per bushel in Montana. Most of the cost for Montana is due to storage and handling costs. While these charges are unrealistic, they were handled the same way in the model with and without dam breaching. As a result, the difference between the two cases is likely to be more realistic than the estimates for each case.

Table 3.3-12. Dam-breaching Grain Shipments and Transportation, Storage, and Handling Costs for 2007 Projected Volume, by State[1/] (1998 dollars)

State	Grain Quantity	Transportation Cost ($)	Storage Cost ($)	Handling Cost ($)	Total Cost ($)
Idaho					
Cost per Bushel	32,289,941	.500	.175	.227	.903
Cost per Ton	968,795	16.67	5.83	7.58	30.08
Total Cost		16,148,010	5,652,855	7,342,505	29,143,370
Montana					
Cost per Bushel	6,537,310	.928	3.065	3.313	7.305
Cost per Ton	196,139	30.91	102.16	110.41	243.49
Total Cost		6,063,389	20,038,366	21,655,789	47,757,544
N. Dakota					
Cost per Bushel	2,458,172	1.433	0.0	0.0	1.433
Cost per Ton	73,753	47.78	0.00	0.00	47.78
Total Cost		3,523,573	0	0	3,523,573
Oregon					
Cost per Bushel	980,218	.401	0.0	0.0	.401
Cost per Ton	29,409	13.37	0.00	0.00	13.37
Total Cost		393,165	0	0	393,165
Washington					
Cost per Bushel	84,355,029	.340	.176	.232	.749
Cost per Ton	2,530,904	11.35	.586	7.75	24.96
Total Cost		28,714,849	14,838,964	19,605,738	63,159,551
Totals					
Cost per Bushel	126,620,670	.433	.230	.384	1.137
Cost per Ton	3,799,000	14.44	10.67	12.79	37.90
Total Cost		**54,842,986**	**40,530,185**	**48,604,032**	**143,977,203**

1/ Totals exclude an adjustment of $794,781 calculated by the model and added to the regional total to prevent costs for any movement with dam breaching from being lower than without dam breaching.

Costs associated with grain transport under the dam-breaching condition were converted to average annual amounts for the period of analysis 2007 to 2016. These average annual amounts, computed at zero, 4.75, and 6.875 percent rates of interest, in 1998 dollars, are shown below in Table 3.3-13.

Table 3.3-13. Dam Breaching Condition – Grain, Average Annual Costs, 2007–2106 (1998 dollars)

Discount Rate (%)	Average Annual Cost ($)
6.875	148,870,766
4.750	149,958,712
0.000	152,763,231

3.3.5.5 Non-grain Commodities

For purposes of analysis, non-grain commodities were combined into the same groupings used for the base condition analysis. Estimated transportation costs reflect projected commodity volumes. Transportation costs associated with non-grain commodities for selected years under dam-breaching conditions are presented in Table 3.3-14.

Table 3.3-14. Dam-breaching Condition Total Annual Transportation Costs for Non-grain Commodities for 2002, 2007, 2012, and 2017 (1998 dollars)

Year/Commodity Group	Dam Breaching Case ($ 1998)
2002	
Petroleum	15,350,816
Logs and Wood Chips	49,320,040
Wood Products	5,444,873
Other	6,643,160
Total	76,758,889
2007	
Petroleum	16,441,562
Logs and Wood Chips	49,320,040
Wood Products	6,516,753
Other	7,533,960
Total	79,812,315
2012	
Petroleum	17,520,827
Logs and Wood Chips	49,320,040
Wood Products	8,332,480
Other	8,768,272
Total	83,941,619
2017	
Petroleum	20,184,544
Logs and Wood Chips	49,320,040
Wood Products	10,559,403
Other	10,136,495
Total	90,200,482

Costs associated with non-grain commodities under dam breaching conditions are displayed in Table 3.3-15 as average annual amounts for the period of analysis from 2007 to 2106. These average annual amounts, computed at zero, 4.75, and 6.875 percent rates of interest, are expressed in 1998 dollars.

Table 3.3-15. Dam-breaching Condition Average Annual Costs for Non-grain Commodities, 2007 – 2106 (1998 dollars)

Interest Rate (%)	Average Annual Costs ($ 1998)
6.875	86.898.809
4.750	87.715.836
0.000	89.575.894

3.3.5.6 Infrastructure Requirements and Costs

With dam breaching and a shift of commodities from shipment on the lower Snake River to shipment by rail, there would a significant increase in demand on the region's land-based transportation and grain handling infrastructure. This section addresses rail system requirements, rail car capacity, highway system requirements, and elevator capacity requirements. In all cases, a range of costs (low and high) was estimated due to uncertainties about actual needs and costs. The following sections briefly describe infrastructure needs and present a summary of the associated costs. The methodology employed to identify these costs is discussed in the DREW Transportation Report (DREW Transportation Study Team, 1999).

Rail System Requirements

If dam breaching were to occur, rail system requirements would include improvements to existing rail lines in terms of interchanges between short-line and mainline carriers, track upgrades, and bridge upgrades. In addition, the stock of grain cars would have to be expanded.

Mainline (Class 1) Railroads

Both mainline railroads, BNSF and Union Pacific, would be impacted by dam breaching through the shift of grain and other commodities from the Snake River to rail. In this analysis, it is assumed that all commodities shifted to rail would eventually require the services of these mainline carriers to reach their final destinations at ports on the lower Columbia River. The increase in grain shipments alone would increase traffic on the mainline routes by from about 840 to about 940 railcar-trips per month. Assuming a train size of 108 cars, this represents an increase of from about eight to nine additional trains per month destined to ports on the lower Columbia River. This would be a significant increase in rail traffic, and improvements to the existing mainline system may be needed.

In making the assessment of mainline railroad infrastructure needs and costs, estimates of diverted traffic and generic or "rule of thumb" measures were used. Generic measures for costing the construction or modification of line capacity were developed for this purpose by civil engineers at the University of Tennessee's Transportation Center. Preliminary estimates were discussed with engineering professionals from a number of Class 1 railroads and with experts from private construction firms that are routinely engaged in rail project construction. Officials of BNSF, Union Pacific, and others reviewed these estimates as they apply to the Pacific Northwest rail system. Estimated costs ranged from $14 million to $24 million.

The impact of the need to make infrastructure improvements to mainline railroads on long-run marginal costs of the railroads was evaluated in a study conducted for the Corps by the Tennessee Valley Authority

(TVA) and Marshall University (TVA and Marshall University, 1998). This study examined the estimated increase in volume, assuming that all commodities now moving on the Snake River would be diverted to rail (a worst-case scenario), and a number of strategies for increasing line-haul capacity. The study concluded that the necessary infrastructure improvements could be made without putting any upward pressure on long-run marginal costs or rates.

Short-Line (Class 2) Railroads

If dam breaching were to occur, short-line railroads in Idaho and Washington would likely experience increased shipments of grain. The magnitude of this increase was not projected for individual railroads or even to the short-line railroads as a group as part of this study. As a result, the assessment of impacts on these carriers and the estimates of costs of improvements are general in nature. Cost estimates were not specifically developed for this study. In the case of Washington railroads, costs were taken from a transportation impact study prepared for the Washington State Legislative Transportation Committee (HDR Engineering, Inc. [HDR], 1999). In the case of Idaho railroads, information about the potential shift of grain to rail was provided to representatives of each of the short-line railroads, with a request that they identify any improvements that might be needed and estimated costs, if any.

Current Conditions, Needs, and Costs. Infrastructure needs of the affected short-line railroads in Idaho and Washington would be relatively more impacted than the mainline railroads. The reason for this is that these rail lines are generally in poor condition at present. The poor condition of the lines stems from the fact that most of the short-line railroads are spin-offs of low volume, low revenue/profit segments of the mainline system, and maintenance tends to be deferred. Traffic on most of the operating short-line railroads is limited to speeds from 25 to 45 miles per hour. Assessments of current needs have been made for both Idaho and Washington and are included in the respective state railroad plans. These analyses identified current maintenance needs amounting to about $21 million. Completion of this maintenance work is needed even if the four lower Snake River dams are not breached.

Incremental Infrastructure Needs with Dam Breaching. To identify incremental improvements that might be needed with dam breaching, representatives of the railroads that would be impacted by dam breaching were contacted and asked to identify any potential additional improvements. In addition, information from other sources was used to identify needed improvements and costs. Needed improvements that were identified include interchanges with mainline railroads, track upgrading, and "other." All of the improvements that were identified were associated with railroads in Washington. To date, no needs have been identified for railroads in Idaho. The cost of the improvements for Washington railroads was estimated to range from about $20 million to $24 million.

Rail Car Capacity

If dam breaching were to occur, approximately 1.1 million tons of grain would transfer to rail. In analyzing available information on current railcar availability and costs, a range of the number of cars needed and their costs was developed. At present there is a large surplus of grain cars. For example, BNSF's grain car utilization rate for June 1999 was only about 50 percent. In spite of this, the analysis for this study is based on the premise that additional rail cars would have to be acquired over the long term to move the grain that would shift to rail with dam breaching. A number of factors were considered in the analysis, including the size of the cars, the turn rate, and the cost per car. The resulting costs ranged from about $14 million to about $37 million.

Rail System Congestion

If dam breaching were to occur, the rail system will experience increased traffic. This increase in traffic has the potential to cause congestion on mainlines and at loading and unloading facilities. Congestion on short-line railroads is not considered likely because those facilities are almost universally only lightly used at present. In the case of congestion at loading and unloading facilities, the DREW Transportation Study Team believes that with implementation of the infrastructure improvements identified in this report there would not be a significant increase in delays due to congestion. In fact, it is likely that the system would become more efficient as it adjusts to a more significant role in the transport of grain within the region. This issue was specifically addressed in the TVA and Marshall University study (TVA and Marshall University, 1998). This study concluded that (1) improvements to the system may be needed to avoid congestion and (2) needed improvements could be made without increasing long-run marginal costs or putting upward pressure on rates. The potential for congestion on BNSF and Union Pacific railroads was also reviewed by transportation analysts at both railroads.

Highway System Requirements

Change in Highway Use

Impacts on highway capital and maintenance cost with dam breaching were determined on the basis of the change in the use of highways to transport grain. The change in highway use was computed as the change in truck miles if dam breaching were to occur. Estimates of the change in truck miles with dam breaching are shown in Table 3.3-16, by state. Also shown is the number of alternative origins/destinations for which truck miles would increase and decrease in each state. These changes range from a decrease of about 1.4 million miles in Idaho to an increase of nearly 3.0 million miles in Washington. The decrease in Idaho is explained by the shift of grain to rail, and the increase in Washington is explained largely by the change in the destination of truck shipments from ports on the lower Snake River to ports in the Tri-Cities area. Maintenance cost savings for Idaho were not estimated, and the change in truck miles for Oregon was considered to be too small to be significant. In the case of Washington, costs include miles for grain movements from Montana and North Dakota because the increase in miles would actually occur in Washington.

Table 3.3-16. Summary of the Change in Truck Miles, by State and the Number of Alternate Origins/Destinations with Increased and Decreased Miles

				Number of Alternate Destinations and Change		
State	Sum Of Total Bushels	Increase in Bushel-Truck Miles	Increase in Truck Miles 1/	Miles Increased	Miles Decreased	Total Alternate Destinations
Idaho	24,271,500	(1,235,193,157)	(1,419,762)	4	31	35
Oregon	736,804	30,198,573	34,711	1	0	1
Washington	63,407,459	2,577,756,664	2,962,939	11	4	15
Montana*	4,913,924	757,607,372	870,813	6	0	6
N. Dakota**	1,847,743	265,297,487	304,940	1	0	1
Totals	95,177,430	2,395,666,939	2,753,640	23	35	58

Notes:

*Montana is divided into regions.

**North Dakota is a single region.

1/ For this analysis, number of bushels per truck equals 870.

Highway Infrastructure Improvement Needs

Highway improvements that were identified as necessary to maintain adequate highway performance and minimal travel delay include intersection improvements, pavement replacement or overlay, and more frequent maintenance. Total estimated costs for these improvements range from about $84 million to $101 million. An annual increase in accident costs amounting to about $2 million was also estimated (HDR, 1999).

Highway Congestion

Based on an assumption of a truck capacity of 1,000 bushels (30 tons) of grain per truck-load in the highway congestion analyses, with dam breaching there would be an increase of approximately 95,200 truck trips to the Tri-Cities area in Washington. Based on assumptions used for this study, this would result in an increase of 370 average daily truck trips, or about 45 trips per hour. With the implementation of the highway improvements identified in this report, highway congestion should not increase, however, additional, more detailed, engineering and traffic studies would be required to determine what highway improvements would actually be needed.

Elevator Capacity Requirements

With dam breaching, it is projected that about 1.1 million tons of grain would shift from the river to rail. In addition, it is projected that an additional 2.7 million tons of grain would be shifted from lower Snake River ports by truck to the Tri-Cities for barging to ports on the lower Columbia River. Additional storage and handling capacity would be needed at both export facilities located on the lower Columbia River and at river ports in the Tri Cities area.

Rail Car Unloading Capacity at Export Elevators

Analysis of current rail unloading capacity at export terminals showed a total daily capacity of about 85,000 tons (1.7 million tons per month). This amount excludes the new terminal planned at Hayden Island, which will have a capacity of 6 million tons per year or 500,000 tons per month. To determine if existing capacity could accommodate the increased rail shipments of grain with dam breaching, historical monthly rail car unloadings at Columbia River export elevators from 1988 to 1997 were analyzed. Based on this analysis of historic peak monthly volume and expected peak additional volume with dam breaching, the maximum expected demand on rail unloading facilities with dam breaching is estimated to be about 1.6 million tons, which is somewhat less than existing capacity. Based on this analysis, it was determined that no additional capacity would be needed with dam breaching.

Rail Car Storage at Export Elevators

With dam breaching there would be an increase of from eight to nine unit trains per month being delivered to export terminals, or from about 840 to about 940 rail cars. The actual amount of storage required, however, would be significantly less because of the turn rates. The turn rates used in the analysis reduce the number of additional rail cars actually needing storage from a range of 840 to 940 cars to a range of 280 to 670 cars. In addition, assuming an even flow of shipments only about one-half of the cars would be at the terminals for unloading at any one time. The other one-half would be in the process of being loaded. Thus, rail storage at export terminals or on rail sidings in the area would only be needed for about 140 to 325 additional cars. Except at Kalama, a facility that primarily handles corn, rail cars are

not stored at the export terminals unless they are actually being unloaded. Loaded and empty cars must be shuttled between the terminals and sidings on a daily basis.

To meet this demand for additional rail car storage, the most likely option was determined to be construction of a single new siding long enough to accommodate the additional cars. The estimated cost of the siding, including track, rights-of-way, turnouts, and control points, ranges from about $2.0 million to $4.1 million.

River Elevators

Grain that would continue to be shipped to export terminals by truck/barge would be trucked to the Tri-Cities area before being loaded onto barges for the remainder of the trip. The estimated volume of grain is about 2.7 million tons (90 million bushels). Analysis of the operating characteristics of river elevators showed that additional capacity needed at the confluence or the Tri-Cities area would range from 10.8 million to 36 million bushels of storage and put-through capacity, depending on the turnover ratio ultimately achieved. Estimated costs for this range of capacity are from about $58.7 million to about $335.4 million, depending the type of facility (barebones or state-of-the-art) and capacity. These estimates include the cost of rail trackage and access roads.

Country Elevators

Based on information obtained from country elevator operators for the SOR and updated for this study, it was determined that capacity at country elevators is adequate. The costs for improvements to upgrade railhead facilities in Washington were estimated to range from about $14.0 million to $16.9 million. Loading and unloading facilities at railhead country elevators in Idaho are considered to be adequate to accommodate the increase in rail shipment without any improvements.

3.3.5.7 Summary—Dam Breaching Condition

Annual NED Transportation Costs

Annualized transportation costs associated with all commodities under the dam-breaching condition are displayed below in Table 3.3-17. Annual costs are shown for discount rates of zero, 4.75, and 6.875 percent, are expressed in 1998 dollars, and are based on a 100-year period of analysis from 2007 to 2106.

Table 3.3-17. Summary of Dam-breaching Condition Total Average Annual Costs—All Commodities, 2007 – 2106 (1998 dollars)

Discount Rate (%)	Average Annual Cost ($)
6.875	235,769,575
4.750	237,674,548
0.000	242,339,125

Adjustment of Annual Costs to the Base Year 2005

Average annual costs in Table 3.3-17 were adjusted to the base year of 2005 to be consistent with analyses of other fish restoration alternatives. This was done by discounting the values for 2007 to 2106 (Table 3.3-17) by 2 years at the appropriate discount rate. The adjusted annual costs are shown in Table 3.3-18.

Table 3.3-18. Annual Costs Adjusted to the Base Year of 2005—All Commodities (1998 dollars)

Interest Rate (%)	Average Annual Costs ($)
6.875	206,411,548
4.750	216,608,063
0.000	242,339,125

Infrastructure Capital Costs

In addition to the annual NED costs shown above, expenditures on transportation infrastructure would also be required to increase the capacity of the system prior to actual implementation of dam breaching. These costs are not part of the cost of the Federal project to breach the four lower Snake River dams, but would be required as a direct result of implementation of dam breaching. Shipping, handling, and storage costs used in this analysis include the amortized capital and operating costs of all of the components of the transportation system. A key assumption in the analysis is that capacity can be added to the system at a cost that is no higher than the cost of the capacity that now exists. On this basis, the annual cost of infrastructure improvements is already embedded in the shipping, storage, and handling costs used in the analysis. Therefore, it is appropriate that infrastructure costs not be included in the estimated transportation costs with dam breaching. A summary of infrastructure improvements that would be needed and estimated ranges of costs are provided below in Table 3.3-19.

Table 3.3-19. Summary of Estimated Costs of Infrastructure Improvements Needed with Dam Breaching (1998 dollars)

Infrastructure Improvements	Estimated Costs ($) Low	High
Mainline Railroad Upgrades	14,000,000	24,000,000
Short-Line Railroad Upgrades	19,900,000	23,800,000
Additional Rail Cars	14,000,000	26,850,000
Highway Improvements	84,100,000	100,700,000
River Elevator Capacity	58,700,000	335,400,000
Country Elevator Improvements	14,000,000	16,900,000
Export Terminal Rail Car Storage	1,985,000	4,053,000
Total	**206,685,000**	**531,703,000**

3.3.6 Comparison of Base and Dam Breaching Conditions

3.3.6.1 Increase In Transportation Costs of Grain

The increased costs of transporting grain with dam breaching are displayed below in Table 3.3-20. In terms of the cost per bushel, the increase in cost with dam breaching ranges from a high of 21 cents per bushel for Montana to a low of approximately 6 cents per bushel for Oregon. The changes in costs for storage and handling are explained by the increased use of country elevators that have a slightly higher cost than river elevators whose use would decrease if dam breaching were to occur. The change in transportation costs is due to the difference in cost between alternative modes and changes in distance.

Table 3.3-20. Increase in Grain Shipments and Shipping Costs with Dam Breaching for 2007 Projected Volume, by State[1/] (1998 dollars)

State	Grain Quantity	Transportation Cost ($)	Storage Cost ($)	Handling Cost ($)	Total Cost ($)
Idaho					
Cost per Bushel	32,289,941	.153	.028	.013	.194
Cost per Ton	969,668	5.11	0.92	0.42	6.46
Total Cost		4,954,984	894,385	410,294	6,259,663
Montana					
Cost per Bushel	6,537,310	.210	0.0	0.0	.210
Cost per Ton	196,139	7.02	0.00	0.00	7.02
Total Cost		1,376,031	0	0	1,376,031
N. Dakota					
Cost per Bushel	2,458,172	.106	0.0	0.0	.106
Cost per Ton	73,753	3.55	0.00	0.00	3.55
Total Cost		261,556	0	0	261,556
Oregon					
Cost per Bushel	980,218	.063	0.0	0.0	.063
Cost per Ton	29,409	2.09	0.00	0.00	2.09
Total Cost		61,328	0	0	61,328
Washington					
Cost per Bushel	84,355,029	.137	.019	.009	.165
Cost per Ton	2,530,904	4.58	0.62	0.29	5.49
Total Cost		11,586,875	1,580,001	737,028	13,903,904
Totals					
Cost per Bushel	126,620,670	.144	.020	.009	.173
Cost per Ton	3,802,423	4.80	0.65	0.30	5.75
Total Cost		**18,240,774**	**2,474,386**	**1,147,322**	**21,862,482**

1/ Costs shown do not include an "adjustment" cost that was calculated by the model to prevent the cost of any movement with dam breaching from being less than it was estimated to be in the base condition. The total regional adjustment amounts to $794,781.

The estimated additional costs for transport of grain as a result of dam breaching were converted to average annual values for the period of analysis from 2007 to 2106. These annual amounts, in terms of totals, cost per ton, and cost per bushel and computed at three different discount rates are displayed in Table 3.3-21. The values shown reflect 1998 price levels.

Table 3.3-21. Average Annual Change in Shipping Costs of Grain with Dam Breaching at Selected Discount Rates[1/] (1998 dollars)

Cost Increase	Discount Rate		
	6.875%	4.75%	0.00%
Transportation Cost Increase			
Total ($)	18.827.438	18.965.029	19.319.712
Cost per Ton ($)	4.96	4.99	5.09
Cost per Bushel ($)	.1487	.1498	.1526
Storage Cost Increase			
Total ($)	2.553.967	2.572.632	2.620.745
Cost per Ton ($)	0.67	0.68	0.69
Cost per Bushel ($)	.0202	.0203	.0207
Handling Cost Increase			
Total ($)	1.184,223	1.192.877	1.215.186
Cost per Ton ($)	0.31	0.31	0.32
Cost per Bushel ($)	.0094	.0094	.0096
Total Annual Cost Increase			
Total ($)	22.565.628	22.730.538	23.155,643
Cost per Ton ($)	5.94	5.98	6.10
Cost per Bushel ($)	.1782	.1795	.1829
Total Bushels	126,620,670		
Total Tons (33.33 bu/ton)	3.799,000		

1/ Values exclude adjustments calculated by the model to prevent estimated costs with dam breaching from being lower than costs without dam breaching, as follows: 0.00 percent interest. $269.805; 4.75 percent interest. $264,855; and 6.875 percent interest $262.933.

3.3.6.2 Increase in Transportation Costs of Non-grain Commodities

The estimated additional transportation costs of non-grain commodity movements as a result of dam breaching were computed for each commodity group and for the same selected years as those used for grain. As with grain, no additional increase in volume is forecast beyond 2017. These costs are shown below in Table 3.3-22.

Table 3.3-22. Average Annual Change in Shipping Costs for Non-grain Commodities With Dam-breaching, by Commodity Group, and at Selected Discount Rates (1998 dollars)

Year/Commodity Group	Cost Increase ($)
2002	
Petroleum	512.071
Logs and Wood Chips	1.440.861
Wood Products	1.064.591
Other	518.133
Total	3.535.656
2007	
Petroleum	548.456
Logs and Wood Chips	1,440.861
Wood Products	1,274,167
Other	587,610
Total	3,851,094
2012	
Petroleum	584,458
Logs and Wood Chips	1,440,861
Wood Products	1,629,181
Other	683,880
Total	4,338,380
2017	
Petroleum	673,314
Logs and Wood Chips	1,440,861
Wood Products	2,064,593
Other	790,595
Total	4,969,363

The estimated additional transportation costs of non-grain commodity movements were also converted to average annual values for the period of analysis from 2007 to 2106. These annual amounts, computed at three discount rates, are presented in 1998 dollars in Table 3.3-23.

Table 3.3-23. Average Annual Change in Shipping Costs for Non-grain Commodities With Dam Breaching (1998 dollars)

Discount Rate (%)	Average Annual Cost ($)
6.875	4,623,910
4.75	4,709,693
0.00	4,904,266

3.3.6.3 Increase in Transportation Costs — All Commodities

Table 3.3-24 presents the average annual increase in shipping costs that would result if dam breaching were to occur. This increase presented at three discount rates addresses both grain and non-grain commodities. These costs include the adjustments referred to in Table 3.3-21, footnote 1.

Table 3.3-24. Average Annual Shipping Cost Increase for All Commodities (1998 dollars)

Discount Rate (%)	Average Annual Cost ($)
6.875	27,452,471
4.750	27,705,085
0.000	28,329,717

3.3.6.4 Adjustment of Annual Costs to the Base Year

Average annual costs in Table 3.3-24 were adjusted to the base year of 2005 to be consistent with analyses of other economic impacts. This was done by discounting the values for 2007 to 2106 (Table 3.3-24) by 2 years at the appropriate discount rate. The adjusted annual costs are shown in Table 3.3-25.

Table 3.3-25. Average Annual Cost Increase—All Commodities, Adjusted to the Base Year of 2005 (1998 dollars)

Discount Rate (%)	Average Annual Costs ($)
6.875	24,034,173
4.750	25,249,421
0.000	28,329,717

3.3.7 Risk and Uncertainty

3.3.7.1 Sources of Risk and Uncertainty

The dam breaching alternative raises a considerable amount of uncertainty with regard to the magnitude of economic and/or financial impacts that could potentially be experienced with plan implementation. One primary area of uncertainty as it relates to dam breaching is the capability of the existing transportation system to adjust to accommodate the types of changes among modes and routings that are projected with river closure. A second area of uncertainty is the magnitude of financial impact that may be experienced by producers and shippers of commodities given the extensive transformation that would occur within the transport sector of the Pacific Northwest. Issues of risk and uncertainty include concerns about system capacity, the cost of improvements that may be needed, potential transportation rate impacts, impacts to roads and highways, and impacts on the rail system. To address the potential impacts of these and other related issues, several sensitivity analyses were developed in an attempt to identify the range of additional economic and financial costs that could potentially be experienced with river dam breaching. Following is a list of risk and uncertainty sources addressed in the DREW Transportation System Impacts Analysis Report, 1999. In addition, the sensitivity to the transportation model to alternative assumptions was assessed. A summary of this assessment is presented below in Section 3.3.7.2.

Sources of risk and uncertainty that were assessed during the study:

- Capacity
- Railroad
- Export elevators
- River elevators
- Roads and highways
- Modal rates
- NED efficiency loss with monopoly increase in rates
- Transportation system reliability
- Construction of a petroleum pipeline
- Grain forecast
- Potential impacts on the export market for grain
- Duration of transition to equilibrium with dam breaching
- The incidence of infrastructure costs.

3.3.7.2 Sensitivity of Model Results to Input Values and Assumptions

The ACCESS database model used for the analysis of transportation system costs required a number of assumptions and estimated input values. Modifying any of these assumptions would change the results produced by the model. Key assumptions and input values used in the model were reviewed, and effects of the use of alternative assumptions and values were determined. The review, however, was limited to a qualitative assessment. An attempt at establishing probable ranges of values was not made, nor were additional model runs made using alternative assumptions. Summary results of the review and assessment are presented in Table 3.3-26.

3.3.8 Unresolved Issues

3.3.8.1 General

There are a number of unresolved issues relating to the analysis, especially the modeling of the transportation system with and without dam breaching. These issues are identified and briefly described below.

3.3.8.2 Commodity Forecasts

Commodity forecasts used for the analysis were developed from forecasts of commodity movements on the lower Columbia River deep-draft navigation channel. These forecasts were developed for the Corps'

Table 3.3-26. Qualitative Assessment of the Effect of Using Alternate Assumptions and Input Values in the Transportation Analysis Model

Variable and Existing and Alternate Assumptions	Effect on Model Results
Base Commodity Level • Assumption: Base commodity levels used are for 1996. • Alternate Assumption: Use 1997 levels.	• The assumption used results in a higher base volume for grain than if the volume for 1997 were used. If the volume in 1997 is representative of the future, the impact of dam breaching is overstated (1997 grain shipments decreased by about 20 percent from 1996). • Use of 1997 as the base would decrease the total volume of grain in the system, and the amount that would be affected by dam breaching. This would reduce the estimated increase in cost by a proportional amount: i.e., by as much as 20 percent. If 1997 shipments are a deviation from the norm, rather than the basis for a new trend, this would understate long-term impacts of dam breaching.
Commodity Forecast • Assumption: Forecasts were derived from forecasts developed for the Columbia River Channel Deepening Study. In the context of Snake River shipments, these are demand-based forecasts. • Alternate Assumption: Develop forecasts specific to Snake River by analysis changes in production by commodity group.	• The accuracy of the forecast used depends entirely on the accuracy of the forecast developed for the Columbia River Channel Deepening Study. The effect on model results is unknown without development of an alternate forecast. Costs for grain are not sensitive to the forecast at the per-ton or per-bushel level. • The alternate forecast methodology would link the forecast directly to production in the Snake River hinterland. As a result, such a forecast might be more defensible. It is not possible to predict whether this forecast would be higher or lower than the forecast used.

Table 3.3-26. Qualitative Assessment of the Effect of Using Alternate Assumptions and Input Values in the Transportation Analysis Model

Variable and Existing and Alternate Assumptions	Effect on Model Results
Commodity Origins	
• Assumption: Origins for grain are at the county level, except for Montana (six regions) and North Dakota (one region for the entire state). Origins for non-grain commodities (except farm commodities) are specifically defined.	• Distance for farm direct to river or rail is computed from the center of the origin county. Distance is not computed for farm to country elevator movements. Accuracy of the cost estimates is reduced for grain and other farm commodities.
• Alternate Assumption: Expand the model to include greater detail.	• The level of detail could be expanded at the farm level. This would improve accuracy and would allow all transportation costs to be estimated. Modeling cost would be much higher.
Storage Costs	
• Assumption: Storage costs are charged at country elevators and at river elevators. Duration of storage is the same. Average costs are used for each type of facility.	• The assumption that river elevators are used for long-term storage is questionable. Also, the assumption that all grain is stored is questionable. The assumption almost certainly overstates storage costs.
• Alternate Assumption: Base storage duration and costs depend on actual industry practice, including shipments during harvest that do not require harvest.	• This would increase the accuracy of the model. It would require more detailed data on storage costs by type of facility (river, country, and railhead) and inclusion of a demand function in the model. Revisions would improve the accuracy of the model, and estimated costs would ÿ• D• • • • ÿ• D• • • • ÿ• D• • • • ÿ• •
Handling Costs	
• Assumption: Handling costs are charged at each facility through which grain moves, except at export elevators. Costs used are for river elevators and country elevators. Costs at railhead facilities are assumed to the same as for other country elevators. Costs at export terminals are assumed to be the same for rail and barge shipments.	• Assumptions that handling costs at railhead facilities are the same as at country elevators and that handling costs at export terminals are the same for rail and barge shipments are probably incorrect. Handling costs may be overestimated or understated.
• Alternate Assumption: Develop and include estimates of handling costs for all types of elevators for both rail and barge modes in the model.	• This would provide for a greater level of detail and would change estimated costs, but the direction of the change is not certain.

Table 3.3-26. Qualitative Assessment of the Effect of Using Alternate Assumptions and Input Values in the Transportation Analysis Model

Variable and Existing and Alternate Assumptions	Effect on Model Results
Transportation Costs • Assumption: Reebie model estimates of modal costs are used. • Alternate Assumption: Use existing rates in the model.	• Reebie model estimates may contain errors in both truck and barge costs. Truck costs appear to be high, and barge costs may be low. Correction of the errors is needed. Since costs tend to be lower than rates (except for long-haul truck), use of costs reduces estimated impacts of dam breaching. • Use of rates would modify estimated changes in modal shift of grain and costs. Truck rates are lower than estimated costs, so use of rates would decrease cost impacts. Rail costs are slightly lower than rates, so use of rates may not change the result by a significant amount. Barge rates are much higher, relative to costs, than rail rates, so their use would make rail a much more attractive alternative and would reduce the estimated cost impact of dam breaching.
Elevator Capacity • Assumption: The model does not include capacity or a capacity constraint. • Alternate Assumption: Include a capacity function in the model.	• The absence of a capacity function in the model does not allow for analysis of system capacity requirements or identification of potential capacity constraints at specific locations. This may lead to underestimating capacity requirements. • To be very useful, the capacity function would have to be elevator-specific, and alternative routings of grain movements in the event of a capacity constraint would have to be included in the model. This type of optimization model would greatly improve the accuracy of assessment of capacity needs with dam breaching, but would require a significant data gathering and modeling effort.

Table 3.3-26. Qualitative Assessment of the Effect of Using Alternate Assumptions and Input Values in the Transportation Analysis Model

Variable and Existing and Alternate Assumptions	Effect on Model Results
Seasonality of Shipments • Assumption: The model does not include a demand function. • Alternate Assumption: Include a demand function in the model.	• The capability of the system to meet seasonal fluctuations in grain shipments was assessed by examining the peak historic single-month demand adjusted to what it would be with increased rail shipments. This showed that there is sufficient capacity. A number of factors could cause this estimate to be either high or low. • Including a demand function in the model could potentially identify grain-handling constraints at hinterland and terminal elevators. Accurate modeling would require detailed data on handling capacity of all elevators, including rail car handling and unloading. This would require a significant modeling effort, and it would be difficult because of the numerous variables to consider. The effect on model results is not predictable.

study of the feasibility of deepening the deep-draft channel from Portland to the ocean. The forecasts developed for this study were obtained by simply prorating the forecast for the lower river to the Snake River on the basis of the Snake River's historic share of shipments on the lower Columbia River. Arguments have been made that this type of forecast is inappropriate because it does not actually include consideration of sources of commodities in the Snake River hinterland.

3.3.8.3 Modeling Logic and Use of Adjustments

The transportation system model is based on the logic that the current pattern of commodity shipments reflects shippers preferences and, in general, is representative of a must be an optimized least-cost system. On this basis, modelers designed the model to prevent the cost of any commodity movement from being lower with dam breaching than it was without dam breaching. The modeler's objective was accomplished by including an adjustment in the model that is equal to the difference between the cost of commodity movement with dam breaching and the cost without dam breaching. If the cost of the movement with dam breaching is lower than it was estimated to be without dam breaching, the difference is added to the estimated cost with dam breaching, thus making the costs the same for both conditions.

The IEAB questions the validity of the use of the adjustment on the basis that it distorts the results of the modeling effort. They point out that all models are extractions from reality and that it is inappropriate to make adjustments to try to make them match reality. In the case of the DREW model, there are a number of reasons why the model would show lower costs for some movements with dam breaching than without dam breaching. First and foremost is the fact that some people do things for other than economic reasons. This kind of non-economic behavior cannot be captured in a model. Secondly, the problem could be due to errors in the model: i.e., errors in transportation, storage, or handling costs. The IEAB has stated that the adjustment should be deleted from the model. The effect of doing so would reduce the net difference between the with and without project conditions.

3.3.8.4 Truck Costs

Truck costs used in the transportation system model are significantly higher than truck costs estimated for the Corps in a study by the Upper Great Plains Transportation Institute. A preliminary review of Reebie Model truck costs for a sampling of movements showed that there is an error in the way driver costs were calculated, making them much higher than they apparently should be. For example, the UPGTI study reported a total allocated cost for long-haul truck movement of grain of $1.04 per mile, with a driver cost of $0.29 per mile. By comparison the cost for one movement of 870 miles (round-trip) in the transportation system model has a cost of $2.716 per mile, with a driver cost of $1.315 per mile. Correction of errors in truck costs used in the model would significantly lower the cost of truck movements of commodities and could change (decrease) the volume of grain that is predicted to shift to rail with dam breaching.

3.3.8.5 Barge Costs

There is a significant variation between barge costs as estimated by the Reebie Barge Model and rates that are actually charged by the barge industry. For example, the cost estimated by the Reebie Model for shipping grain from Almota, Washington, to Portland, Oregon is $3.07 per ton compared with the actual rate charged by the industry of about $6.07 per ton. Industry representatives have stated on numerous occasions that the costs estimated by the Reebie Barge Model are incorrect (too

low): In response to the comments by representatives of the barge industry, Corps analysts reviewed three other studies of barge costs. The finding was that all of the studies indicated that rates are significantly higher than costs. In addition, input data for the Reebie Model were provided to an industry representative for review and comment. That review has not been completed. If barge costs are in fact higher than the Reebie Model costs used in the transportation system model, use of actual costs in the model would tend to offset the effect of reducing truck costs as described above.

3.3.8.6 Storage and Handling Costs

Model estimates of storage and handling costs for grain shipped to the Northwest from the states of Montana and North Dakota amount to nearly $6.50 per bushel. This is almost double the market value of wheat and clearly is not representative of the long-run equilibrium condition that the model is supposed to represent. Corps modelers are aware of this problem and, in fact, have corrected it, however, revised model results were not available for inclusion in the draft report. For the draft report, it is important for readers to understand that the error has no effect on the primary objective of the model—to estimate the change in costs with dam breaching—because these costs are the same with and without dam breaching.

Another issue concerning storage and handling costs is the use of "rates" rather than costs. In this regard, the model is inconsistent because costs are used for alternative transportation modes, whereas rates are used for handling and storage. One effect of the use of rates is that the model uses the same handling rate for rail and barge shipments at the downriver export terminals. This is consistent with actual practice because the terminals do in fact charge the same handling rate for both rail and barge shipments. Industry representatives have, however, stated that handling costs for rail shipments are actually about 40 percent higher than for barge shipments.

3.3.8.7 NED Effects of Redirected Cross-River Road Traffic

The Lower Monumental Dam is the connecting link between Lower Monumental Road (south side) and Devils Canyon Road (north side), and the Lower Granite Dam is the link between Lower Deadman Road (south side) and Almota Road (north side). Alternate routes are Washington 126 that crosses the river at Lyons Ferry and Washington 127 that crosses the river at Central Ferry, respectively. Use of the alternate routes could increase overall travel distance for users, depending on their origin and destination. While the other two dams, Ice Harbor and Little Goose, have road crossings, they do not appear to link major state or county roads and so appear to be primarily used by project operators and tourists. The IEAB has stated that the NED effects of severing the roadways that are linked by the Snake River dams should be quantified.

3.3.8.8 Inconsistency in Truck Long-Haul Distances

The transportation system model defines long-haul truck movements of grain as movements of 150 miles or more, and it uses a cost that is based on the availability of a two-way haul (backhaul). However, the study conducted for the Corps by the Upper Great Plains Transportation Institute found that the break between short-haul (local market) and long-haul-truck movements is 250 miles. This distance was defined on the basis of the finding that this is the distance where rail shipment of grain becomes competitive with truck shipment. The UGPTI study further found that long-haul truck shipment of grain only occurs in the presence of two-way haul opportunities. This finding is consistent with modeling done by the Corps that assumes the presence of backhaul for all long-

distance (150 miles or more) truck shipments of grain. The IEAB has stated that there should be consistency in long-haul assumptions between the two studies.

3.3.8.9 Continued Use of Existing Snake River Elevators With Dam Breaching

With dam breaching and closure of the Snake River to barge traffic, 12 river elevators could become abandoned. In 1998 these facilities handled a combined total of over 100 million bushels of grain (Tidewater Barge Lines, Inc., July 1999). With dam breaching, the alternate river port becomes the Tri-Cities area. Construction of replacement facilities in the Tri Cities could cost over $300 million. A less costly alternative may be to continue using some of the existing facilities as railroad loading facilities. In particular, the location of the facilities at Central Ferry might make them an attractive railhead alternative. Additional study would be needed to determine if conversion of these facilities to a railhead would lower overall costs.

3.4 Water Supply

3.4.1 Introduction

This report focuses on the evaluation of Snake River water users and the potential effects to these groups as a result of actions to improve anadromous fish returns. Although there are four different alternatives under consideration to improve anadromous fish returns, only Alternative 4, Dam Breaching, would directly affect the operation of river pump stations and wells used for irrigation and other purposes.

Irrigation water for farm purposes is the dominant consumptive use of the water pumped from the river. Other potentially impacted water user groups that are included in the following analysis are municipal and industrial (M&I) pump operators and private well users.

Section 3.4.2 of this analysis focuses on effects to irrigated agriculture. Section 3.4.2.1 provides a description of irrigated agriculture in Franklin and Walla Walla Counties and Section 3.4.2.2 describes more specifically the farms that withdraw water from the lower Snake River at the Ice Harbor reservoir. Three separate approaches to measuring the economic effect to irrigators under dam breaching conditions are included. Section 3.4.2.3 describes the economic effects based on the modified cost approach. Section 3.4.2.4 indicates the economic effects based on the change in farmland values under dam breaching. Whereas Section 3.4.2.5 provides an estimate of economic effects based on the change in net farm income. Conclusions about the effect of dam breaching on irrigated agriculture are presented in section 3.4.2.6.

Section 3.4.3 of this report discusses the effect on other water users, particularly users of municipal and industrial (M&I) pumps and privately owned wells. The required modification costs to M&I pump stations and private wells provide the measurement of the economic effects to these other water users.

Section 3.4.4 of this report summarizes the economic effects to water users. Section 3.4.5 describes the sensitivity analysis of the economic effects to irrigated agriculture.

Basic Assumptions

- The economic analysis of water supply effects relied heavily on existing studies and data. In general, the analysis of economic effects was primarily limited to estimating the capital costs of system modifications. The rationale for the limits on the analysis were that the data from existing studies appeared reasonably good, net farm income analysis would be an extensive and expensive effort with probable limited returns, and relative to other NED costs water supply effects are small. For instance, under dam breaching conditions the total water supply NED effects are less than 10 percent of the hydropower costs.
- Irrigated farmland operators that currently pump water from the Ice Harbor Reservoir will no longer be able to pump water from the reservoir under dam breaching conditions, and the value of the impacted 37,000 acres of farmland would be reduced to non-irrigated grazing land. This change in farmland value represents the economic effect of dam breaching on pump irrigators.

- Economic effects under dam breaching conditions to municipal and industrial pump station operators and privately owned well users are determined by estimating the system modification costs.

- The economic effects to water users that are described in this report would be incurred the year that dam breaching is implemented.

3.4.2 Irrigated Agriculture

3.4.2.1 Profile of Irrigated Agriculture, Franklin and Walla Walla Counties

The counties of Franklin, Walla Walla, Whitman, Columbia, Garfield and Asotin in Washington and Nez Perce County in Idaho border the four lower Snake River reservoirs. However, this water supply analysis focuses on only those portions of the counties that are served by water from the four reservoirs or would be impacted by changes in these reservoirs.

Of the counties listed above irrigated agriculture is dominated by Franklin and Walla Walla. The very large river pumping stations used for irrigated farming that would most directly be impacted under dam breaching conditions are located in these two counties. Irrigation water is withdrawn from both the Columbia and Snake Rivers out of the McNary and Ice Harbor pools, respectively. However, this analysis is concerned with the lower Snake River water users located near Ice Harbor reservoir in the counties of Franklin and Walla Walla.

Since the construction of Ice Harbor Dam in the early 1960s, private entities have financed the development of infrastructure necessary to grow irrigated crops in the region. The majority of the irrigated farmland adjacent to Ice Harbor reservoir is irrigated by pumping water from the Snake River. Some additional land is irrigated using wells.

A review of irrigated acreage information from several sources indicates that there are about 37,000 acres using pumped Snake River water at Ice Harbor reservoir. The Columbia River System Operation Review study that was completed in 1995 identified 36,400 acres of irrigated farmland using Snake River water pumped out of Ice Harbor reservoir (Corps, 1995). A recent inventory effort completed by Corps of Engineers, Portland District economists documented about 34,000 acres of irrigated cropland using water pumped out of Ice Harbor. Although specific documentation is not readily available some local agriculture experts indicated that they believe the actual number of acres irrigated with water pumped from Ice Harbor is somewhat greater than what the above estimates indicate. For instance, the Natural Resources Conservation Service (NRCS) regional field office estimated that there are over 50,000 acres of irrigated farmland adjacent to Ice Harbor. However, a breakdown between the acres irrigated with pumped water and well water was not provided. Consequently, it is surmised that a substantial amount of this additional acreage is irrigated using well water.

For purposes of analyzing the economic effects to pump irrigators under dam breaching conditions, it is estimated that approximately 37,000 irrigated acres in Franklin and Walla Walla counties would be impacted. Table 3.4-1 compares the statewide number of irrigated acres with these two counties. In addition, the table displays the number of acres of specific crops within these two counties.

Table 3.4-1. Acres by Crop Type: State of Washington Compared to Franklin and Walla Walla Counties

Crops	State of Washington Acres	Franklin County and Walla Walla County Acres	Two County Percentage of State Total (%)
Total Irrigated Acres	1,705,000	318,281	18.7
Field Corn	170,000	33,400	19.7
Potatoes	161,000	55,500	34.5
Asparagus	23,000	13,000	56.5
Peas	42,200	5,900	14.0
Onions	13,400	4,600	34.3
Sweet Corn, proc.	75,300	18,400	24.4
Apples	142,000	9,400	6.6
Cherries	14,000	1,700	12.1
Vineyards	31,000	2,300	7.4

Source: Washington Agricultural Statistics, 1996-1997, Washington State Department of Agriculture. U.S. Census Bureau, 1997 (Agriculture).

Comparing the number of irrigated acres that would be impacted by the breaching of Ice Harbor dam to the total amount of irrigated acres within the two counties and statewide show that the quantity of impacted farmland is relatively small percentage. The 37,000 acres represents about 12-percent of the irrigated farmland in Franklin and Walla Walla counties and about 2-percent of the irrigated farmland in Washington State.

Information in Table 3.4-1 also shows the relative importance of specific crops in these two counties compared to the state total. Both Franklin and Walla Walla counties are important field corn producers, together accounting for a fourth of the state's production in 1995. Potatoes are an important crop as well. Franklin and Walla Walla counties contribute to the state harvest significantly and comprise about a third of the state production. Both Franklin and Walla Walla counties also have a lot of acreage devoted to vegetable crops, including asparagus, carrots, peas, onions and sweet corn. Some vegetable crops are found on farms that irrigate from the Ice Harbor reservoir, however the total acreage is not large. Both Franklin and Walla Walla counties have significant acreage in orchards for the production of apples, cherries and grapes as well. A fairly large amount of orchard crops are also grown on farmland adjacent to Ice Harbor reservoir.

3.4.2.2 Profile of Irrigated Agriculture at Ice Harbor Reservoir

This section provides information about non-Federal agricultural water users who pump from the Ice Harbor reservoir.

It has been determined, based on a survey of farms that at least 37,000 acres of land are presently irrigated with water pumped out of Ice Harbor reservoir. Table 3.4-2 summarizes information about the pumping stations that are used to withdrawal Snake River water for agricultural purposes. Data about the farm operations indicate that some additional acreage is irrigated using wells rather than the Snake River pumps. For instance, one of the orchard operators has more horsepower than the river station pumps, and total irrigated acreage is considerably greater than the amount identified in

Table 3.4-2. Changes to the economics of the pump irrigated land component of these farms may directly impact the economic viability of the land that relies on wells. It was, however, assumed for this study that as long as irrigation water is available the land remains economically viable.

Table 3.4-2. Crop Data for Agricultural Pumpers from Snake River, 1996/1997

Pump Stations (Ref. No.) 1/	Total Acreage	Total Acreage Irrigated from Snake	Primary Crops	Notes
IH-1	1,500	1,500	Sweet corn, onions, potatoes	Shared ownership with IH-12
IH-2	4,500	4,500	Hybrid cottonwood	Land/station leased
IH-3	12,000	9,500	Potatoes, wheat, field corn, onions, sweet corn	
IH-5	4,100	4,100	Hybrid cottonwood	Land/station leased
IH-6	5,000	2,200	Field corn, wheat, potatoes	
IH-7	2,900	2,700	Grapes, apples	
IH-9	540	540	Apples	Shared station with IH-10
IH-10	4,000	1,800	Apples, cherries	
IH-11	6,017	4,008	Apples and cherries, sweet corn, potatoes, wheat, peas, field corn	Includes 1000 acres of orchards
IH-12	900	900	Field corn, potatoes, asparagus, wheat	Owns 30% of IH-1 station
IH-16	600	320	Apples, cherries	
IH-17	1,200	1,200	Potatoes, onions	
IH-18	225	165	Vineyards, apples	
IH-19	500	500	Not determined	Future station
ICE HARBOR TOTAL		**33,933**		

1/ This numbering system matches the numbering used in an earlier water supply analysis developed for the Corps (Anderson-Perry, 1991). Pump stations 1H-4, 1H-8 and 1H-13 through 1H-15 are not included in this table because water pumped via these stations is not used for agricultural production.

Source: Survey of Farms, 1997/1998.

Only a portion of the acreage is in permanent crops like fruit tree orchards or vineyards, and, therefore, acreage by crop varies from year to year as crops are rotated. Potatoes, for example, are grown on the same land only one year in three or four for disease control. An estimate of farmland relying on Ice Harbor water by crop type is presented in Table 3.4-3.

Table 3.4-3. Estimated Percentage of Crops by Type

Crop	% of Crop Types
Cottonwood/Poplar	23.2
Potatoes	14.9
Field Corn	13.5
Fruit Tree Orchards	11.1
Wheat	9.5
Vineyards	6.2
Sweet Corn	5.4
Onions	3.0
Undefined Percentage	13.2
Total (37,000 acres)	100

Primary Source: Survey of Farms, 1997/1998.

As Table 3.4-3 shows, cottonwood is the largest crop in percentage terms and is grown for pulp and paper production. Potatoes are the next biggest crop although this will vary year to year. Fruit tree orchards and vineyards are high valued crops, and recently the number of acres has been expanded primarily due to the planting of apple trees in the last two years. Also, a relatively minor amount of acreage is in asparagus, peas and other crops.

Table 3.4-4 summarizes river station pump plant data on size and output for these farms. There are about 75 pumps with a total of about 42,000 horsepower. This does not include booster pumps that are situated between the river station and point of use at a higher elevation than the river station. Electrical usage is for 1996 except for IH-2 and IH-5, and IH-16. Those data are for 1997. Table 3.4-4 was developed using information from a previous consultant's report (Anderson Perry, 1991), Walla Walla District engineers data, and farm manager interview data.

3.4.2.3 Economic Effects: Pump Modification Cost Approach

Introduction

The objective of the analysis of irrigation water users is to estimate the net economic losses under dam breaching conditions as compared to the base condition. A total of three different approaches are presented in this report. These are the pump modification cost approach, the farmland value approach, and the net farm income approach. The pump modification cost approach discussed in this section of the report is the estimation of the cost to modify or replace river pump stations so that the current water supply capability is maintained under dam breaching conditions.

The estimated modification costs discussed below provide an upper bound estimate of the economic effects to irrigators under dam breaching conditions. This approach to measuring the economic effects to irrigators is not intended to imply such investments are necessarily cost effective when compared to farm production and income. The true NED costs would be no greater and may be less than the cost to continue to provide equivalent quantities of water. That is, the farmer can always limit cost increases to the cost of modifying the pumping station (and higher O&M costs) but may be able to do better by changing crops, production techniques, etc.

Table 3.4-4. River Station Pump Plant Data, Ice Harbor Reservoir

Pump Stations (Ref. No.)[1/]	River Mile	Number of Pumps	Horse-Power	Head (ft)	Electrical Usage	Water Usage a-f (yr)	Notes
IH-1	12	8	2,650	360	$217,000	7,917 (95)	Station 30% by IH12
IH-2	12	5	4,500	260	11,000,000 kW	14,000 (97)	
IH-3	17	11	13,500	460	$941,000 30,636,500 kW	29.5 in/ac average	
IH-5	12	5	4,700	260	9,000,000 kW	8,800 (97)	
IH-6	14	8	2,260	260	$112,440 4,591,000 kW	4,341 (96)	
IH-7	12	9	4,900	462	$229,688	12,216 (96)	
IH-9		6					Shared with IH-10
IH-10		8	4,400	410	$234,195	NA	
IH-11	20	6	3,900	310	$182,607	7,275 (96)	
IH-12	12			415	about $72/ac	23 in/ac average	
IH-16	10	2	300	360	330,000 kW	2 af/acre (97)	Water usage will increase when trees mature
IH-17		4	1,300	350	$133,000		
IH-18		2	240	230		18 in/ac	
IH-19		1	125	6			Planned Station

1/ This numbering system matches the numbering used in an earlier water supply analysis developed for the Corps (Anderson-Perry, 1991). Pump stations 1H-4, 1H-8 and 1H-13 through 1H-15 are not included in this table because water pumped via these stations is not used for agricultural production.

Source: Anderson Perry, 1991 and Survey of Farms, 1997/1998.

Initially, the modification cost approach was to be the only analysis applied to measure the economic effects to water users under dam breaching conditions. As a result of significant increases in the estimated cost to modify the pump systems, the study group determined that the modification cost approach overstated the economic effects and additional economic analysis was warranted.

Sections 3.4.2.4 and 3.4.2.5 of this report describe the other two approaches used to assess the economic effects to Ice Harbor water users. As is shown later in this document the high cost to modify the pumping system makes the farmland value approach summarized in section 3.4.2.4 the most reasonable (least cost) estimate of economic effects to Ice Harbor water users.

The remainder of this section of the report summarizes the pumping station modification costs.

System Modification for Dam Breaching Conditions

Three significantly different options to supply equivalent water quantities were identified and considered. Each option is briefly described below. For additional details, refer to Technical Appendix D-Natural River Drawdown Engineering and Technical Appendix E-Existing Systems and Major System Improvements Engineering.

Important requirements of an acceptable modified irrigation system are that the system will be: operational prior to breaching of the Ice Harbor reservoir dam; function through a full range of river stages without interruption; and able to handle a potentially large quantity of suspended sediment.

Under current conditions, the pump stations withdraw water from the Ice Harbor reservoir and pump the water uphill several hundred feet to the individual farm distribution systems. The majority of pumps are vertical turbine type. Without the pool of water created by the Ice Harbor dam, the pumping station intakes would be completely out of the water. Following are the modified systems that were considered.

Option 1

The first option, investigated conceptually in at least one previous study, is to modify each existing pump station by extending pipes and installing additional or bigger pumps according to increases in lift requirements (Anderson-Perry, 1991).

It was initially thought that this approach would function similar to the existing system and minimize the extent and cost of modifications. Unfortunately, during the review of this concept, the engineering study team identified a number of technical concerns. The team was not able to identify acceptable locations to place the new pump stations that would work with the fluctuating and meandering river conditions under dam breaching conditions. This stretch of the river has a wide, flat bottom with substantial silt, sand, and gravel deposits, and as the material erodes under dam breaching conditions, the river would likely meander and affect the availability of water at the pump stations. In addition, erosion at the pump stations could undermine the pump, piping, and intake structures. The engineering study team also indicated serious concern about how the sediment could be managed at many of the locations new pump stations would need to be established. Another issue raised by the team is the technical problems with constructing this new system without causing some interruption in irrigation water deliveries. Any untimely interruption of irrigation water would severely impact permanent crops such as orchard and vineyards.

Option 2

Replacement of river stations with groundwater sources is the second option that was considered. Based on discussions with Dr. Robert Evans, irrigation specialist in the County Extension office in Prosser, Washington, this does not appear to be a feasible option. Wells present numerous problems. There would likely be difficulties in receiving Department of Ecology approval. These wells would need to be drilled deep, increasing both first costs and operating costs. Additionally, the well water would require treatment in order to counter high pH levels; and high sodium content in the well water could lead to soil sealing problems. There is also concern that this system could not be installed without some interruption in irrigation water deliveries, and the interruption of irrigation water deliveries would severely impact permanent crops such as orchard and vineyards.

Option 3

After consideration of options 1 and 2, the study team focused its efforts on a third approach that they determined would technically work and would satisfy the other criteria noted above. This option includes one large pumping station and distribution system with a sediment basin. This system would provide water via a single river pump station and the water would be delivered to each farm through a main pipeline distribution system. Each farm level pump would also require modifications in order to connect to the main pipeline distribution system. A sediment basin/reservoir is included as a component of the one large pump station system because it is anticipated that sediment effects will be significant

Locating the pump station at a narrow point in the river reduces problems with river fluctuation and meandering. Under dam breaching conditions, the water levels would still be deep in this stretch of the river and the rock channel would ensure that erosion would not impact the availability of water for pumping. Another advantage of this one pump station system is that sediment problems can be addressed using only a single sediment control basin.

Option 3 was selected to carry forward in this analysis because it avoids the problems and uncertainties associated with the others. In other words, option 3 was the only approach that the engineering study team agreed would technically work. Some additional discussion of the selected modification system follows in the next subsection. For additional details, refer to the Engineering Appendices (Technical Appendices D and E).

Description and Costs Associated with the Modified Irrigation System

The selected irrigation system to quantify economic costs under dam breaching conditions is a pressure supply system that will withdraw water at one river location (option 3). The primary irrigation system consists of six main components: the pumping plant at the river; the pipe network; connections to existing irrigation systems; secondary pumping plants; a control system; and a sediment control reservoir.

Pumping Plant

The intake structure would be divided into five bays with a peak capacity of 850 cubic feet per second (CFS). Three 1500 horsepower (HP) and two 600 HP vertical turbine pumps would be secured above each of the five bays. Electrical switchgear, valves to allow each pump to be isolated from the system for maintenance work, and appropriate screening would be included.

Pipe Network

The pipeline network would be epoxy lined and polyethylene coated steel pipe. The pipeline would begin at the pump station near river mile 20 on the south shore of the Snake River, and would be 12 feet in diameter at the main pumping plant. The pipeline would then extend downstream about 5,200 feet at which point a branch of the system would cross the river. The branch of the pipe network would cross the river 2700 feet to Emma Lake and then continue another 4,500 feet to the existing pump station at IH11. The main pipeline would extend along the south shore of the lower Snake River for approximately 47,500 feet with branches as needed to connect the other stations to the main pumping plant.

Existing Irrigation System Connections, Secondary Pumping Plants, Control System

Two of the existing pumping plants are multi-pump configurations that would require reconfiguration in order to connect to the pipe network. Several of the existing pumping plants would require manifolds to be constructed and installed to connect each pump to the piping network. Additionally, at each existing and secondary plant, isolation valves would be required to allow for individual plant maintenance. Flow meters would also be installed. It is anticipated that about six air release/vacuum valves would be required for the system. Drain valves and discharge piping would be required to allow the pipeline to be drained. At each branch pipe and each significant directional change in the pipe network, concrete thrust blocks would be used to control potential thrust damage.

Sediment Control Reservoir

The construction of a reservoir addresses sediment concerns and surge control. The reservoir would be a holding pond with approximately 14,000 acre-feet storage which would be required to detain the water sufficient time for the settling of suspended solids.

In order for the modified irrigation system to be functional in time for use by irrigators, construction of the river intake, the pipeline network, and the reservoir would need to be initiated 18 months in advance of dam breaching.

Total construction costs for option 3, the large pumping station with a sediment reservoir, are summarized in Table 3.4-5. The total construction costs are equal to $291,481,000.

The modified agricultural pump system will likely result in increased energy and other operation and maintenance expenses as well. Additional lift of the irrigation water with new pumps or the conversion of existing pumps will result in higher operating costs. Specifically, the greater horsepower will increase the cost of power to the water user. Additional equipment may also require greater maintenance expenditures and may increase the future replacement costs.

Increased maintenance necessary to treat sediment-related problems, even with a sediment control reservoir in place, is not easily predictable. Replacement of worn parts of pumps, valves, sprinklers, and filters may initially be significant.

Therefore, the extent of increased operation and maintenance (O&M) expense associated with the modified irrigation system is not fully understood. Information documented in the Anderson Perry study (1991) is used as a placeholder value because no specific estimate of the additional O&M costs was completed. That study identified additional O&M expenses associated with modifying the existing pump stations equal to $3,573,000/year (1998 dollars).

Construction costs are estimated to equal $291,481,000 with the added O&M expenses associated with the modifications to the irrigation pump stations at Ice Harbor reservoir equal to $3,573,000/year. The estimated modification cost provides an upper bound measurement of the economic effects to irrigators; and the true NED costs would be no greater than this estimate.

Table 3.4-5. Cost Estimate of Modifying Ice Harbor Agricultural Pumping Stations, 1998 Dollars

Component	Construction Costs ($)	
Mobilization, Demobilization & Prep.	11,896,148	
Earthwork for Structures	5,207,616	
Utilities	6,997,734	
Access Road	4,849,592	
Pipelines	71,865,100	
Pumping Plant	9,243,520	
Pumping Machinery	52,678,290	
Subtotal, Pump Plant System		162,738,000
Subtotal, Sediment Reservoir		128,743,000
Pump Plant & Reservoir Total		291,481,000

Source: Corps, 1998.

3.4.2.4 Economic Effects: Farmland Value Approach

Introduction

In this section of the report the measurement of the economic effects to irrigators under dam breaching conditions is determined based on a change in farmland values. In order to accomplish this, typical land values for farm properties at Ice Harbor reservoir are presented. This information was compiled through discussions with farm managers, cooperative extension agents, farmland appraisers, agricultural economics professors, and the use of published enterprise budget sheets for a number of crops. An analysis of this data provides an estimate of typical farmland value and permits the quantification of the economic effect to the farmland under dam breaching conditions.

Approximately 37,000 acres of irrigated farmland currently rely on pumped water from the Snake River, specifically Ice Harbor reservoir. In addition to the estimated 28,400 acres of the more traditional irrigated cropland there are 8,600 acres of poplar plantations.

Farmland Value

Following is a summary of the estimated value of the different types of irrigated farmland in southeastern Washington State.

Row Crops

A local farm manager knowledgeable about market values indicated that supply of land on the market is currently limited and demand is high, resulting in high prices for land. He estimates that row cropland, anchored by potatoes in the crop rotation, has an approximate value of $2,500 to $3,500 per acre. This estimate is based on potatoes generating net income of $450 per acre and

other crops (wheat, sweet corn, alfalfa, beans, field corn) generating net income of $225 per acre. Assuming potatoes are grown one year in four, average net income per acre is approximately $280. Land appraisal data from other sources confirms that this is a reasonable estimate of the value of row cropland. Of course there are many variables that could cause actual values to vary from this range, such as terrain, soil, and accessibility to water.

Apples, Cherries

The Farm Business Management Report for red delicious apples states that the value "varies considerably depending on the age of trees and their current and potential production levels. The better apple orchards in this area are 10 to 20 years old with an annual production level of 40 bins or more per acre. Such an orchard is currently valued at about $12,000 per acre. Eventually the value of the orchard will decrease due to age of trees and the irrigation system to about $5,000 per acre."

In the opinion of an extension economist for Washington State University, valuation of $12,000 per acre for apple orchards is probably low for the Ice Harbor farms. The Farm Business Management Report is based on Wenatchee, Washington orchards. The orchards in the Ice Harbor vicinity are probably younger and more productive than Wenatchee orchards. His estimate of value is near $15,000.

Another, higher value estimate for fruit orchards was put forth by Benton County Cooperative Extension. Value increases with tree density, quality of irrigation system, frost-control equipment, trellised orchards, and tree maturity. In general, the Ice Harbor orchards are dense with good irrigation and frost control systems, and are trellised and have mature crops. For these farms establishment costs run from $25,000 to $32,000 per acre. Initial tree costs alone, assuming 1,000 trees per acre at $7 per tree, may account for $7,000 per acre of these establishment costs. The market value should reflect these establishment costs.

Appraised value data for four orchards sold within the last two years in southeastern Washington documented that the values of these properties ranged from $9,900 to $11,900 per acre. In the opinion of a local appraiser, $10,000 per acre is a reasonable average value to use for apple orchard land.[1/]

Vineyards

Washington State University Farm Business Management Reports also provide estimates of the costs of establishing a Concord grape vineyard. For this perennial crop four years are needed to develop a mature vineyard. Total investment costs over the four year period, net of revenues, are about $7,000. Including the value of raw land, estimated at $2,500 per acre, raises the total value of a mature vineyard to $9,500. This assumes the market equilibrium price would eventually stabilize at a level to cover costs.

Local appraiser information indicates that $5,500 per acre for vineyard property is a reasonable average value estimate for the study area.

[1/] Regional land valuation experts that were contacted by the Walla Walla District economist provided appraisal data. Because this type of data for specific properties is usually confidential, the appraiser names and properties are not disclosed.

Poplars

Estimating the value of poplar/cottonwood acreage is difficult because of the lack of available historical market value data. Pacific Northwest Regional Extension Bulletin "High Yield Hybrid Poplar Plantations in the Pacific Northwest" (PNW356) is one source of value information. The net present value per acre of the crop, defined as discounted future revenues less discounted future costs, varies with assumptions about product price, age at harvest, and productivity, among others. Table 9 of the bulletin lists present values for different combinations of these factors. For example, as pulp price varies from $20 to $32 the net present value per acre with harvest at age 7 ranges from $-44 to $431. This range reflects net present value sensitivity to price. Presumably, the market value of the property would be a combination of the raw land value and the market's assessment of the net present value of the cottonwood crop at any point in the crop's cycle. In addition, the market value should include the value of the irrigation system, if any.

Information provided by local appraisers indicates that the tree farms are generally appraised similarly to row crop property. Therefore, the estimated market value of this type of farmland is $2,500 to $3,500 per acre.

Farmland Value Summary

Table 3.4-6 is a summary of the estimated market value of the primary types of irrigated farmland in the region. In addition, local farm appraisers and agricultural experts have indicated that farmland near Ice Harbor reservoir is generally not suitable for growing non-irrigated crops such as wheat because of low rainfall. Therefore, this farmland without irrigation water is limited to some grazing a short period of the year and would sell for $75 to $150 per acre.

Table 3.4-6. Farmland Value Estimates for Selected Crops

Type of Cropland	Value per Acre ($)
Row Crops	2,500 to 3,500
Vineyards (at maturity)	5,500 to 9,500
Apple Orchards (at maturity)	10,000 to 32,000
Poplars	2,500 to 3,500
Non-irrigated Farmland	75 to 150

Estimated Economic Effect Based on a Change in Land Value

Detailed crop information for about 20,000 of the irrigated acres at Ice Harbor was collected through interviews with farm operators. The crop information in conjunction with the farmland value data described above was used to determine the average per acre value of irrigated farmland in the region. Table 3.4-7 summarizes the results of the analysis of six farms that comprise over 20,000 of the irrigated acres that would be impacted under dam breaching conditions. Based on the farmland value approach, the average per acre value of irrigated farmland of $4,100. Corps of Engineers planning guidance suggests that any economic analysis of the change in land values should be based on the market value of the property.

Table 3.4-7. Estimated Market Value of Irrigated Acreage Served by Pumped Water from Ice Harbor Reservoir, Sample Farms (1998 dollars)

Farm/Crop Distribution	Acres	Per Acre Farmland Value ($)	Total Value ($)	Value/Acre by Farm ($)	Percent of Sample Acreage by Farm (%)	Average Per Acre Value of Total Farmland ($)
Farm A						
Potatoes	*	2,500	-			
Winter Wheat	*	2,500	-			
Grain Corn	*	2,500	-			
Onions	*	2,500	-			
Sweet Corn	*	2,500	-			
Total	9,500		23,750,000	2,500	47	
Farm B						
Potatoes	*	2,500	-			
Winter Wheat	*	2,500	-			
Grain Corn	*	2,500	-			
Total	2,210		5,525,000	2,500	11	
Farm C						
Red Delicious Apples	*	10,000	-			
Concord Grapes	*	5,500	-			
Total	2,700		16,650,000	6,167	13	
Farm D						
Red Delicious Apples	*	10,000	-			
Sweet Cherries	*	12,000	-			
Total	1,800		18,100,000	10,056	10	
Farm E						
Potatoes	*	2,500	-			
Winter Wheat	*	2,500	-			
Sweet Corn	*	2,500	-			
Hay	*	2,500	-			
Seed Peas	*	2,500	-			
Grain Corn	*	2,500	-			
Subtotal	2,913		7,282,500	2,500	14	
Farm F						
Red Delicious Apples	*	10,000	-			
Sweet Cherries	*	12,000	-			
Subtotal	1,030		10,560,000	10,252	5	
Average Value Per Acre, Sample Farms:						**4,100**

* Distribution of acreage by crop confidential.

The procedure used to estimate the per acre value of farmland is summarized in Table 3.4-7 and briefly discussed in this paragraph. A total farm value estimate was developed for each of the six farms by multiplying the acres of each crop grown at each farm by the low end range of the per acre crop land values presented in Table 3.4-6. The average per acre value of each farm was then determined by dividing the total farm value by the number of acres. The average per acre value of each farm was then multiplied by the percentage of the combined acreage associated with that farm and summed to give an overall average per acre value of irrigated farmland of $4,100.

By applying this average per acre value to the total amount of irrigated crop acreage, and adding the value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland an estimate of the net economic impact to pump irrigators under dam breaching conditions is estimated.

Therefore: ($4,100 * 28,400 acres) + ($2,500 * 8,600 acres) - ($100 * 37,000 acres) =

$116,440,000 + $21,500,000 - $3,700,000 = $134,240,000.

The economic effect of dam breaching measured on the basis of a change in farmland value is equal to $134,240,000.

3.4.2.5 Economic Effects: Net Farm Income Analysis

Introduction

This analysis is included to verify that the previously described market value approach provides reasonable land value estimates. For the net farm income analysis typical crop budgets and the associated net returns are evaluated. The capitalized value of net farm income for the different crops in the base condition compared to the dam breaching condition provides a measure of the economic effects to irrigation water users. Including the analysis of typical crop budgets provides an indication as to whether or not the land value analysis approach presents a realistic estimate of economic effects.

Approximately 37,000 acres of irrigated farmland currently rely on pumped water from the Snake River reservoirs. In addition to the estimated 28,400 acres of the more traditional irrigated cropland there are 8,600 acres as poplar plantations.

Estimated Economic Effect Based on a Change in Net Farm Income

An analysis of typical crop budgets and agricultural statistics is summarized in this section. All data are based on Farm Business Management Reports of Washington State University (Table 3.4-8 lists the crop budgets). The typical farm values discussed in the previous section are recalculated in this section by applying net economic returns using the crop budgets. For each crop they are calculated as the difference between revenues less variable costs and net fixed costs. Net fixed costs are defined as total fixed costs less land rents and establishment charges. Typically, the establishment charge includes costs such as the purchase and planting of trees/vines with the initial development of the farm property. By excluding land rents and establishment charges from fixed costs, the net return estimate reflects a return to land and investments over time in the enterprise. It is believed this return corresponds well to the market value of the enterprise on a capitalized basis.

Net Return = Total revenues – (Total Variable Cost + Net Fixed Costs)

Where Net Fixed Cost equals Total Fixed Cost less Land Rent and Establishment Charge.

Table 3.4-8 is a summary of the crop budget data for all crops but cottonwoods. The table identifies the specific Washington State University crop budgets used in the analysis.[2/] The last column in this table provides an estimate of net returns per acre. These estimates do not. in fact. represent any one particular operation. Therefore. the farm income and value estimates must be viewed as general guidelines about typical income levels generated by the types of crops grown in Franklin and Walla Walla counties.

Applying the net returns shown in Table 3.4-8 to the crop distributions of specific farms in the Ice Harbor area provides another method of determining the average per acre value of farmland. Net returns are applied only to the acreage now served by irrigation water from the Ice Harbor reservoir. The acreage and crop distribution information was collected through interviews with the farm operators.

The crop information in conjunction with the crop budget data is used to determine the average per acre value of irrigated farmland in the region. Table 3.4-9 summarizes the results of the analysis of the six farms constituting over 20,000 of the irrigated acres that would be impacted under dam breaching conditions. Total return is the product of acreage and net return per acre. For each farm, total return per crop is summed to derive a total for all acreage irrigated from the Snake. This represents total annual net returns per farm. This annual value is capitalized in the column labeled "Present Value". A discount rate of 6.875 percent and a horizon of 20 years were assumed in calculating present value. This present or capitalized value of each farm, weighted by the number of acres provides an estimate of the market value of the land. This evaluation indicates that the average per acre value of irrigated farmland equals $4,500, a similar result compared to the land value approach.

By applying this average capitalized net return value to the irrigated crop acreage and adding the value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland an estimate of the economic impact to pump irrigators under dam breaching conditions is estimated.

Therefore: ($4,500 * 28,400 acres) + ($2,500 * 8,600 acres) - ($100 * 37,000 acres) =

$127,800,000 + $21,500,000 - $3,700,000 = $145,600,000.

Water Supply

Conclusions about the Effect of Dam Breaching on Irrigated Agriculture at Ice Harbor

As noted in the introduction, the purpose of this analysis is to determine the direct economic effects to agricultural users of pumped water from the lower Snake River under dam breach conditions. As a result of unanticipated escalation in the estimated cost to modify the pump stations, the evaluation of farmland values and typical net returns using available information were introduced into the analysis. This approach was added to the analysis for comparison to the modification cost approach,

[2/] Note budgets reflecting 1997 costs and returns are now available, but were not when the analysis was initiated. A brief review of the 1997 budgets and comparison to the older versions indicates that the overall per acre net income would be slightly higher than what has been used in this analysis.

Table 3.4-8. Per Acre Revenue, Cost, and Profit Data for Irrigated Cropland Served by Ice Harbor Reservoir Water (1998 dollars)

Crop	Price ($/unit)	Quantity (unit/acre)	Total Revenue ($/acre)	Total Variable Cost ($/acre)	Total Fixed Cost ($/acre)	Land Rent ($/ac)	Amortized Establishment Charge ($/acre)	Total Fixed Cost Less Land Rent & Establishment Charge ($/acre)	Per Acre Return to Land & Establishment ($/acre)
Potato	85	28.5	2,423	1,770	654	400	-	254	399
Alfalfa	95	8	760	258	340	180	59	101	401
Winter wheat	3.5	120	420	220	169	125	-	44	156
Grain Corn	102	5	510	430	193	125	-	68	12
Silage Corn	20	30	600	532	198	125	-	73	(5)
Sweet Corn	64	9	576	376	256	180	-	76	124
Concord Grapes	7	250	1,750	979	1,454	125	915	414	357
Sweet Cherries	925	7	6,475	3,916	2,628	240	1,528	860	1,699
Red Delicious Apples	125	40	5,000	2,325	1,916	-	765	1,151	1,524
Asparagus	0.50	4,000	2,000	1,431	752	150	301	301	268
Onions	90	27	2,430	1,671	561	200		361	398
Seed Peas	15	30	450	325	220	125		95	30

Source: Selected Farm Business Management Reports Produced by Washington State University, Cooperative Extension.

EB1609, Cost of Establishing and Producing Sweet Cherries In Central Washington, Hinman et al, 1991.

EB1720, 1992 Estimated Cost of Producing Red Delicious Apples In Central Washington, Hinman et al, 1992.

EB1667, 1992 Enterprise Budgets for Alfalfa Hay, Potatoes, Winter Wheat, Grain Corn, Silage Corn, and Sweet Corn Under Center Pivot Irrigation, Hinman et al, 1992.

EB1572, Economics of Establishing and Operating a Concord Grape Vineyard, Schimmel et al, 1990.

EB1588, Establishment and Annual Production Costs for Washington Wine Grapes, Chvilicek et al, 1990.

EB1753, 1993 Estimated Cost and Returns for Producing Onions Under Rill Irrigation Columbia Basin, Washington, Hinman et al, 1993.

EB1666, 1992 Enterprise Budgets for Fall Potatoes, Winter Wheat, Dry Beans, and Seed Peas Under Rill Irrigation, Hinman et al, 1992.

EB1779, Asparagus Establishment and Production Costs in Washington, Joshua et al, 1994.

and to determine whether or not it provides an acceptable estimate of NED costs. A summary of the estimated economic effects measured by each approach is provided in Table 3.4-10. This table shows that the economic effects to pump irrigators under dam breaching condition range from $134.2 to over $300 million ($291.5 million construction plus O&M) based on the three approaches used in this analysis. The pump modification costs are significantly higher than the estimate of the change in land value, therefore, it is reasonable to conclude that this option is not economically viable, and is an overstatement of the economic effects. The land value approach is therefore carried forward as the approach to measure the economic effects to pump irrigators at Ice Harbor reservoir.

Table 3.4-9. Estimated Total Return and Market Value of Acreage Served by Pumped Water from Ice Harbor Reservoir, Sample Farms (1998 dollars)

Farm / Crop Distribution	Acres	Net Return per Acre (based on crop budgets) ($)	Total Return ($)	Present Value by Farm ($)	Value / Acre by Farm ($)	Percent of Sample Acreage by Farm (%)
Farm A						
Potatoes	*	399	-			
Winter Wheat	*	156	-			
Grain Corn	*	12	-			
Onions	*	398	-			
Sweet Corn	*	124	-			
Total	9,500		2,000,700	21,477,819	2,261	47
Farm B						
Potatoes	*	399	-			
Winter Wheat	*	156	-			
Grain Corn	*	12	-			
Total	2,210		274,040	2,931,604	1,327	11
Farm C						
Red Delicious Apples	*	1,524	-			
Concord Grapes	*	357	-			
Total	2,700		1,430,000	15,305,233	5,669	13
Farm D						
Red Delicious Apples	*	1,524	-			
Sweet Cherries	*	1,699	-			
Total	1,800		2,751,950	29,439,599	16,355	10
Farm E						
Potatoes	*	399	-			
Winter Wheat	*	156	-			
Sweet Corn	*	124	-			
Hay	*	12	-			
Seed Peas	*	30	-			
Grain Corn	*	12	-			
Subtotal	2,913		588,681	6,297,541	2,162	14
Farm F						
Red Delicious Apples	*	1,524	-			
Sweet Cherries	*	1,699	-			
Subtotal	1,030		1,592,470	17,035,803	16,540	5
Avg. Value Per Ac., Sample Farms:						4,500

* Distribution of acreage by crop confidential.

Table 3.4-10 summarizes the present value estimates for the pump modification approach, the irrigated farmland value approach, and the net farm income approach. Included are the average annual costs using different discount rates. It has been determined that the most reasonable (least cost) estimate of the NED costs is provided by the approach that estimates the change in farmland value based on assessed values under dam breaching conditions.

Table 3.4-10. Comparison of the Approaches to Measure Direct Economic Effects to Pump Irrigators, Under Dam Breach Conditions (1998 dollars)

Approaches to Measure Direct Economic Effects	Direct Economic Effect ($)	Average Annual Cost (6.875% Discount Rate) ($)	Average Annual Cost (4.75% Discount Rate) ($)	Average Annual Cost (0.0% Discount Rate) ($)
Pump Modification Cost Approach				
--Construction:	291,481,000	20,065,550	13,979,400	2,914,800
--O&M:		3,573,000	3,573,000	3,573,000
Total Annual Modification Cost		23,638,550	17,552,400	6,487,800
Loss of Irrigated Farmland Value:	-	-	-	-
(1) Assessed Value Approach	134,240,000	9,241,100	6,438,100	1,342,400
(2) Net Farm Income Approach	145,600,000	10,023,100	6,983,000	1,456,000

3.4.3 Other Water Users

3.4.3.1 Introduction

In this chapter, potential economic effects to other water user groups under dam breaching conditions are described and analyzed.

Specifically, the economic effects to municipal and industrial (M&I) water users and private well users in close proximity to the reservoirs are measured. For these other water categories, the measurement of economic effects are based on the required system modification costs. These modification costs serve as a proxy measurement of the true NED costs.

This report is intended to provide only a brief summary of the modification costs. Additional details about the specific modifications required are provided in the Engineering Appendices (Technical Appendices D and E).

3.4.3.2 Municipal and Industrial Pump Stations

There are several M&I pump stations all located on the Lower Granite pool. Uses range from municipal water system backup, golf course irrigation, industrial process water for paper production, and concrete aggregate washing.

Table 3.4-11 lists these facilities. The largest station is owned and operated by the Potlatch Corporation. Two of the stations of Public Utility District (PUD) #1 in Clarkston have not been

operated in the past few years and there are no plans to use them in the immediate future. The District is considering moving one plant to a new location. One of the stations is a shared station between Atlas Sand and Rock and Lewiston Golf Club. Atlas uses water pumped from a 100 HP plant for washing aggregate and the golf club uses the smaller 60 HP pump to irrigate the course. The remaining plants are small with limited horsepower. These smaller plants are used to irrigate golf courses and parks. Data for these plants are summarized in Table 3.4-11. Sources for this information include managers of the stations, Walla Walla District engineers, and previous consultant documentation (Anderson-Perry, 1991).

Table 3.4-11. Municipal & Industrial Pump Stations on Lower Granite Reservoir

Ref. No.	Station	River Mile	Use	Number of Pumps	Horsepower	Head (ft)	1996 Water Usage
GR-1	PUD #1	143	Water System Backup	3	450	300	Not used in several years
GR-2	PUD #1	143	Water System Backup	3	1,200	400	Not used in several years
GR-3	Clarkston Golf Course	137	Golf Course Irrigation (90 acres)	1	10	40	460,000 gal/day
GR-4	Potlatch Corp. (Clearwater R)	CW 4	Mill process water and steam generation	6	1,050	80	12,287,000,000 gal
GR-11a	Atlas Sand & Rock	142	Concrete aggregate washing	1	100	120	Na
GR-11b	Lewiston Golf Club	142	Golf Course Irrigation	1	60	160	1.0-1.5 mgd in June to Aug.

Sources: Survey of Station Managers; Walla Walla District Engineers 1997/1998; Anderson-Perry, 1991.

Following is a summary of potential pump modifications.

- The two PUD stations have not been used in several years and will not be modified.
- The Clarkston Golf Course potential modifications include construction of a utility building, water intake system, and power supply.
- The Potlatch Corporation station modifications are extensive and include the primary plant intake and the plant diffuser, and potentially a water cooling facility.[3/]
- The Atlas Sand and Rock facility potential modifications include construction of a utility building, water intake system, power supply.
- The Lewiston Golf Course potential modifications include construction of a utility building, water intake system, power supply.

[3/] Final determination about the extent of required system modifications has not been made.

The total estimated modification costs for these municipal and industrial pump stations on Lower Granite reservoir (excluding the park stations) are $11,514,000 to $55,214,000. There is a cost range because the required modification costs for Potlatch Corporation depends on whether or not a discharge water cooling facility will be necessary. The Potlatch Corporation system modifications are either $10.8 million or $54.5 million of the total.

Increased energy costs for the modified M&I pump stations have not been quantified. Of the subset of M&I pump stations the largest pumps are owned by PUD #1 and the Potlatch Corporation which account for over 90 percent of total M&I horsepower. The PUD pumps, which are backup water supply pumps, have not been used in several years and there are no immediate plans for their use. Therefore, quantifying increased energy costs for the systems would be very speculative. The Potlatch pump does not face increased head and consequently energy costs would not be greater under dam breaching conditions compared to current conditions. The remainder of M&I pumps would experience increased pumping costs but the magnitude of those increased costs would be negligible compared to energy costs for agricultural stations.

3.4.3.3 Privately Owned Wells

The number of water wells within approximately one-mile of the Snake River was compiled from well water reports. The well logs were obtained by searching and copying records of the Washington Department of Ecology. Wells within the one-mile distance were included as the range encompassing wells that might be affected under dam breaching conditions. The topographic features of the area, stratigraphy, and surface elevation directly influence which wells would be affected by the change in river water surface elevation.

A total of 228 well reports were counted. Review of the well reports showed that 9 reports were for test wells, 1 for an abandoned well, 2 for replacement wells, and 7 reports for wells that were deepened but not matched with original well reports. Adjusting the number of reports for test wells, abandoned wells, replacement wells, and possible duplication for deepened wells indicates the actual number of functioning wells may be as low as 209.

Some of the reports provided information about what the wells are used for and where they are located. Table 3.4-12 provides a breakdown of the well reports by county and use. In terms of number of well reports, domestic use appears to be the dominant use, followed by irrigation. About 11 percent of the reports had more than one use checked off. In almost all cases where more than one use was indicated, both irrigation and domestic use were indicated. Many of the older reports did not include any usage information.

Only 55 of the well reports indicated the horsepower of the pump. Many of the pumps were smaller sized although horsepower did range up to as large as 700 HP. Average horsepower was 70 and the median horsepower was 10. The average depth of the wells was about 270 feet. Table 3.4-13 summarizes information about the distribution of well pump capacities.

Examination of the individual reports indicates the larger pumps appear to be associated with irrigation usage. From previous information [Anderson-Perry, 1991] and recent phone conversations with farm operators, it is known that some of the agriculture operations have significant irrigation capability from wells. For example, one operation has four well pumps with 1,300 total horsepower irrigating 1,200 acres of potatoes, wheat, sweet corn and onions, while

Table 3.4-12. Number of Well Reports Disaggregated by Use and County

Use	Asotin	Columbia	Franklin	Garfield	Walla Walla	Whitman	Total	Percent of Total (%)
Domestic	40	2	9	3	12	12	78	35
Industrial				1	2	3	6	3
Irrigation	7	1	18	1	9	4	40	18
Multiple	5	5	4	4	3	4	25	11
Municipal	7				2	1	10	4
Other	2		9	2	2	1	16	7
Test Well	3		4			2	9	4
Not Reported	3	4	5	2	15	12	41	18
Total	67	12	49	13	45	39	225	
Percent of Total (%)	30	5	22	6	20	17	100	

Note: County data could not be read on 3 well reports. Uses for these three included 1 test well and 2 not reported.
Source: Well record data, Washington State Department of Ecology.

Table 3.4-13. Distribution of Pump Horsepower for Wells

Horsepower	Number of Pumps
< 2	17
2 – 10	11
10 – 100	17
> 100	10

Source: Well record data, Washington State Department of Ecology.

another operation has two wells with 240 horsepower irrigating 170 acres of vineyards and orchards. An orchards indicated it has two 700-horsepower and five 500-horsepower well pumps (in addition to its eight river station pumps) for irrigation of orchards. It is likely that other agricultural operations also irrigate from wells, but identification of all irrigation well stations was beyond the scope of this analysis.

The Corps analyzed a representative sample of the existing wells to determine potential modifications to the wells and cost. Fifty wells were selected and analyzed. Well log data coupled with topographic features of the area provided information on well depth, stratigraphy, surface elevation, and ultimately which wells would be affected by the change in river water surface elevation. Results of the analysis showed that 21 of the 50 sampled wells would be impacted under dam breaching conditions. Refer to the engineering appendices for a description of each of the 50 sampled wells and modification cost estimate details (Technical Appendices D and E).

For these 21 affected wells in the sample the amount of additional drilling and head that would be required for effective operation at natural river levels was determined. With this information the Corps calculated the necessary modifications, particularly in pump size and increases in well depth that would be required to maintain a constant water supply. The modification cost for the average well was also calculated.

The average cost per well was applied to the entire number of wells anticipated to be affected, as determined from percentages calculated in the representative sample. About 40 percent or 95 wells are expected to need modifications. Table 3.4-14 presents the total well modification cost by reservoir. Total costs are equal to $56,447,000, which includes direct, contingency, project management, and overhead costs.

Table 3.4-14. Well Modification Cost Estimates by Pool (1998 dollars)

Pool	Well Modification Cost ($)
Ice Harbor	18,373,000
Lower Monumental	12,462,000
Little Goose	7,797,000
Lower Granite	17,815,000
Total	56,447,000

Source: Corps, 1998.

The cost estimate was based on a typical cost per well with average increases in pump size and well depth. As a practical matter, each well would have to be considered individually under dam breaching conditions. Only by observing conditions after dam breaching has occurred can one determine exactly how deep a well would have to be drilled to produce water at current rates. It is recommended that all well modifications be performed after dam breaching has occurred. It is unclear what the water well users would do in the interim. An estimate for additional O&M expenses associated with the well modifications has not been determined.

3.4.3.4 Conclusions about the Effect of Dam Breaching on Other Water Users

Table 3.4-15 summarizes the cost of the water supply modifications that are required under dam breaching conditions. These modifications will allow the water users to continue to operate as they currently do. Estimated water supply economic losses are based on the costs of modifying pump stations and wells. Therefore, the water supply economic effects to M&I and private well users are equal to the total modification costs. Average annual costs are calculated using three different discount rates for the 100-year evaluation period.

Table 3.4-15. Summary of Other Water Supply Modification Cost Estimate, M&I and Private Wells (1998 dollars)

Water Supply Category	Construction Cost ($)	Average Annual Cost (6.875% Discount Rate) ($)	Average Annual Cost (4.75% Discount Rate) ($)	Average Annual Cost (0.0% Discount Rate) ($)
Municipal and Industrial Pump Stations	11,514,000 to 55,214,000	792,600 to 3,800,900	552,200 to 2,648,100	115,000 to 552,000
Privately Owned Wells	56,447,000	3,885,800	2,707,200	564,500
Total	67,961,000 to 111,661,000	4,678,400 to 7,686,700	3,259,400 to 5,355,300	679,500 to 1,116,500

Source: Corps, 1998. M&I cost range is due to the current uncertainty about the required modifications to the Potlatch Corporation system.

3.4.4 Summary of Economic Effects to Water Users

Table 3.4-16 summarizes results of the analysis of effects to water users under dam breaching conditions. Three water user categories were evaluated in this report—loss of irrigated farmland value, municipal and industrial pump station modifications, and private well modifications. Results of the analysis of the economic effects are presented using three different discount rates.

The total economic effect associated with the three categories ranges between $202,201,000 to $245,901,000 (in present value terms). This range reflects uncertainty surrounding system modifications that might be required at the Potlatch facilities in Lewiston, Idaho. The loss in irrigated farmland value represents over 50 percent of the total water supply economic effects. It is anticipated that economic effects summarized in Table 3.4-16 would be incurred the year that dam breaching occurred. Therefore, the economic effects do not need to be adjusted to the base year 2005.

Table 3.4-16. Summary of Economic Effects to Water Users (1998 dollars)

Water Supply Category	Economic Effect ($)	Average Annual Cost (6.875% Discount Rate) ($)	Average Annual Cost (4.75% Discount Rate) ($)	Average Annual Cost (0.0% Discount Rate) ($)
Loss of Irrigated Farmland Value	134,240,000	9,241,100	6,438,100	1,342,400
Municipal and Industrial Pump Stations	11,514,000 to 55,214,000	792,600 to 3,800,900	552,200 to 2,648,100	115,000 to 552,000
Privately Owned Wells	56,447,000	3,885,800	2,707,200	564,500
Total	202,201,000 to 245,901,000	13,919,500 to 16,927,800	9,697,500 to 11,793,400	2,021,900 to 2,458,900

Source: Corps, 1998.

3.4.5 Sensitivity Analysis of the Economic Effects to Irrigated Agriculture

A sensitivity analysis of key variables of the irrigated agriculture study is summarized in this section. The results of this sensitivity analysis do not change the estimated economic effects already described, but rather provide an indication of how the estimates would change given different assumptions. The results of the irrigated agriculture analysis present the most likely economic effect of dam breaching, given the available data and necessary assumptions. The intent of this sensitivity analysis is to provide some perspective about the uncertainty in our estimates and demonstrate how the application of different assumptions could change the results.

The sensitivity analysis is focused on two key components of the irrigated agriculture study: (1) the actual number of irrigated acres that would be taken out of production; and (2) the impact of varying the net income estimates. Three separate sensitivity scenarios are presented.

3.4.5.1 Sensitivity Analysis Scenarios

Scenario 1: Orchard and Vineyard Acreage Remains in Production Under Dam Breaching Conditions

The irrigated agriculture analysis concluded that the most likely consequence of dam breaching would be the removal of about 37,000 acres access to irrigation water. This was concluded because no technically and economically viable modified irrigation delivery system was identified under dam breaching conditions. Early on in this study it was determined that not all system modification possibilities, including farm level modifications would be analyzed. And since all combinations were not evaluated it is possible, although speculative, that some of the farm operators would find a way to continue to provide irrigation water to a portion of the farmland, under dam breaching conditions. For this scenario it is assumed that all fruit orchards and vineyards could be kept in production under dam breaching conditions. A summary of the change in economic effects under this scenario follows.

Of the 37,000 acres that are likely to be impacted by dam breaching, approximately 7,750 acres or 21 percent are vineyards and fruit orchards. This 21 percent represents about 51 percent of the estimated value of the 37,000 acres of irrigated land. Consequently, if we assume in this sensitivity analysis that these permanent croplands could be kept in production the overall economic effect on the region would be reduced by about half. Under the assumption that all 37,000 acres go out of production the estimated value of the property is reduced about $134,240,000. Whereas, keeping the permanent crops in production reduces the impact to a little more than $64,170,000.

As noted earlier, the intent of presenting these numbers is to show the sensitivity of the estimated economic effect to a reduction in the number of acres that are impacted. Again, no specific irrigation system was identified to permit this acreage to remain in production. In addition, on-farm or other irrigation system modification costs that would be required to allow irrigation to continue is not included, so the $64,170,000 estimate is unrealistically low. However, it is reasonable to conclude that under these assumptions the economic effects would be no less than $64,170,000.

Scenario 2: Additional Irrigated Acreage Impacted Under Dam Breaching Conditions

This irrigated agriculture report has concluded that the most likely consequence of dam breaching would be the removal of access to irrigation water for about 37,000 acres. The estimated number of acres impacted under dam breaching conditions was determined through interviews with current farm operators. It is believed that the information compiled from the interviews provides a census of pump irrigated acreage that would be impacted under dam breaching conditions. However, during the development of this document some individuals indicated that they felt the actual number of acres that would be impacted is significantly higher. For instance, the Natural Resources Conservation Service (NRCS) indicated there are over 50,000 acres of irrigated farmland adjacent to Ice Harbor. In this analysis it was assumed that the majority of this additional acreage is irrigated with well water, and therefore the economic impacts under dam breaching conditions are captured in the well modification cost estimate. However, if this assumption is incorrect then it is possible, although speculative, that the economic effect under dam breaching conditions is significantly higher. Following is a summary of the change in economic effects under this scenario.

Assuming the additional 13,000 acres are the same mix of crops as the 37,000 acres that were previously evaluated, the economic effects are 35 percent higher. Under the assumption that 37,000 acres go out of production the estimated value of the property is reduced about $134,240,000. Whereas, if we assume that 50,000 acres are impacted then the total economic effect increases to $181,224,000.

The intent of presenting these numbers is to show the sensitivity of the estimated economic effect to an increase in the number of acres that are impacted. Although there has been some speculation that the number of acres that would be impacted as a result of dam breaching may be greater than 37,000, no specific documentation could be identified.

Scenario 3: Net Return Estimates Decreased by as Much as 25 Percent

A major conclusion of the irrigated agriculture report is that breaching of the dams will eliminate access to irrigation water for about 37,000 acres of farmland. In determining the economic effect associated with the removal of irrigation water, an analysis of generic crop budgets for the primary crops was completed and an estimate of the value of impacted farmland was developed. Applying generic budgets to these 37,000 acres required significant generalization of many factors. Variables such as regional differences in irrigation pumping costs, adjustments for salvage values, and real estate taxes were not adjusted/incorporated in the crop budget analysis. In addition, uncertainty about what the political and economic future may hold for agriculture in terms of crop subsidies, impacts to capitalized land values due to changing risk factors, and crop prices received by farmers was not addressed.

As a result of the use of generalized crop budgets in this analysis, the true net return values for the major crops near the Ice Harbor reservoir may actually be lower than the values calculated and used to estimate farmland values. To test the influence of the applied net returns on the estimate of economic impacts, the net returns for all crops are reduced by 25 percent. Following is a summary of the change in economic effects under this scenario.

It was determined in the irrigated agriculture report the weighted value of farmland, based on net returns generated from generic crop budgets, is $4,100 per acre. Assuming that the net returns are actually 25 percent lower than the estimate used in the irrigated agriculture report the weighted value of farmland is $3,075 per acre. The estimated market value of poplar/cottonwood acreage is $1,875 per acre under this assumption. Applying the revised average per acre value to the total amount of irrigated crop acreage, adding the revised value of the poplar tree acreage, and then subtracting the value of non-irrigated cropland results in the following estimate:

($3,075*28,400)+($1,875*8,600)-($100*37,000) = $87,330,000 + $16,125,000 -

$3,700,000 = $99,755,000.

As noted earlier, the intent of presenting these numbers is to show the sensitivity of the estimated economic effect to a change in farmland value estimates. Based on the results of this sensitivity analysis it is reasonable to conclude that the actual economic effect on irrigators is likely between $99,755,000 and $134,240,000.

Conclusions of Sensitivity Analysis

The different sensitivity analysis scenarios are not directly combinable. However, the ranges of economic effects presented under the different scenarios do show how key variables influence the results.

The results presented in the preceding sections of this analysis reflect our best estimate of what is the most likely economic effect of dam breaching, given the available data and necessary assumptions. This sensitivity analysis provides some perspective about the uncertainty in our estimate and demonstrates how the application of different assumptions in this analysis could change the results.

3.4.5.2 Unresolved Issues

Although it is generally agreed that the water supply effects of breaching are not large when compared to the effects on hydropower, navigation, and recreation, reviewers and contributors to this document have identified issues which have not been resolved. Following is a list of the unresolved issues associated with the water supply analysis.

Irrigated Agriculture Effects

- Acceptance of the estimated land value for irrigated and non-irrigated acreage used to measure NED effects. Limited land value appraisal data were available. Therefore, generalized crop budgets were analyzed to verify the conclusions reached with appraisal/local expert opinion information. Questions as to whether the use of the generalized budgets truly corroborate the land value estimates continue. In addition the inclusion of a sensitivity analysis for this same issue does not fully address the issue. Further verification of land values would require supplementing existing appraisal data.
- Agreement as to whether or not it would be possible to keep some of the irrigated acres in production under dam breaching conditions.
- Acceptance of the modified irrigation system engineering cost estimates.

Effects to Municipal and Industrial Water Users and Privately Owned Wells

- Acceptance of the modified M&I water system engineering cost estimates.
- Acceptance of the procedures used to measure the number of wells that would be affected by dam breaching and the engineering cost estimates.

3.5 Anadromous Fish

The section summarizes the findings of the Anadromous Fish Economic Analysis prepared by the DREW Anadromous Fish Workgroup (1999). The purpose of this analysis is to identify the net economic value associated with changes in commercial and recreational anadromous fish harvest.

Projected changes in fish harvest are based on preliminary data developed through the committee-based process Plan for Analyzing and Testing Hypotheses (PATH). PATH provided data for seven index stocks for Snake River spring/summer chinook, a comprehensive review of Snake River fall chinook, and a narrative description evaluating the correlation between Snake River spring/summer chinook and steelhead. In order to analyze the economic effects of future harvests under the different alternatives, the DREW Anadromous Fish Workgroup expanded the PATH results to represent all Snake River wild and hatchery stocks. This economic analysis considered commercial and recreational harvesting of wild and hatchery fish and also sales of hatchery returns for egg, carcass, and food fish sales. Commercial and recreational harvests were allocated to user groups and geographic areas based on existing U.S. and Indian tribal agreements. Fish available after these obligations are met were distributed based on historical harvest distributions. Commercial economic values are based on ex-vessel values, while the recreational fishery value is based on a value per angler day.

The following discussion is divided into six sections. The first section provides a general overview of the changing patterns of anadromous fish production in the Columbia River Basin and briefly discusses West Coast salmon management. This section establishes the context for the economic analysis. Broadly speaking, the anadromous fish economic analysis consisted of three main components: developing estimates of fish returns under each alternative, allocating these fish by fishery and geographic area, and evaluating the NED contribution of subsequent harvests. These three parts of this analysis are discussed in Sections 3.5.2 through 3.5.4, respectively. Section 3.5.5 addresses risk and uncertainty issues associated with this analysis. The final section outlines a number of issues that were unresolved when this analysis was completed.

3.5.1 Overview

3.5.1.1 Changing Patterns of Anadromous Fish Production

To the Indians living along the Columbia River, salmon were their lifeblood, essential to their subsistence, their culture, and their religion. Salmon also played a key economic development role for European settlers. As early as 1828, various trading companies were purchasing and exporting salmon caught by Indians on the Columbia River. The first commercial use of fishery products in Oregon was salmon packing. Demand for salmon grew following development of the canning process in the mid-1800s. Total harvested pounds of salmon and steelhead in the early 1890s are estimated to have ranged from 21 to 33 million pounds.

The history of Columbia River salmon harvest has been one of transition from spears and dip nets, to seine and gillnets, to diesel engines and ocean trolling poles. As salmon became scarcer, gas-powered engines allowed fishermen to venture further out into the ocean. As ocean fisheries developed, most of the fish produced in the Columbia River Basin were harvested in marine waters from California to Alaska. The long-term effects of economic development, hatchery production, and mixed-stock, open-access fisheries have been to reduce the total, and change the species and stock composition, of salmon returning to the Columbia River. Total poundage harvested

commercially in the Columbia River Basin has declined from about 9.090.909.1 kg (20 million) in the 1940s to a recent low of just over 454.545.5 kg (1 million pounds) in 1993 (Radtke and Davis. 1994). As fish numbers and commercial harvests have declined. so have the revenues to fishermen. As water-based economic development took place in the Pacific Northwest. natural-based production was supplemented by artificial propagation.

3.5.1.2 Salmon Management on the U.S. West Coast

Understandings and Agreements

A host of salmon treaties and agreements affect salmon of the Columbia River system. These can be categorized as international understandings. such as the 1992 International North Pacific Fisheries Commission Convention (Shepard and Argue, 1998); the United Nations Convention on the Law of the Sea. which entered into force in November 1994; the Pacific Salmon Treaty (PST) between the United States and Canada; harvest management agreement processes such as the Pacific Fishery Management Council (PFMC); agreements to rebuild the stocks such as the Northwest Power Planning Act; obligations to northwest Indian tribes; and, most recently, Federal mandates to protect salmon stocks under the Endangered Species Unit (ESA). Assumptions about salmon production, allocation agreements, and protection of natural runs used for this analysis took these international understandings into consideration. The PST was being renegotiated at the time of this analysis, so applicable provisions of the new agreement were not included in modeling assumptions.

3.5.2 Anadromous Fish Harvest Forecast Methods

The low rate of returning wild spawners in recent years has raised concerns about the eventual extinction of wild anadromous fish stocks in the Snake River system. During the early 1990s, for example, every two wild spring chinook spawners from the Snake River system returned about 1.2 spawners (Smith, 1998). Factors may include harvesting methods, habitat alterations, hatchery production, hydrosystem operations, and ocean conditions. The economic analysis presented here only addresses the causation factors considered in the PATH process. Readers are directed to the many PATH publications for more information concerning forecasts of harvests and returning spawners for each alternative. The National Marine Fisheries Service (NMFS, 1999) provides a biological evaluation of PATH results to estimate the recovery probabilities of ESA-listed stocks.

Information contained in the PATH results is limited to seven index stocks for Snake River spring/summer chinook, a comprehensive review of Snake River fall chinook, and a narrative description about how smolt-to-adult survival rates (SAR) between Snake River spring/summer chinook and steelhead are correlated. For spring/summer chinook and fall chinook, the information includes numbers of fish harvested in the ocean, river mainstem, and tributaries; harvest rates for ocean and mainstem based on ocean escapement (estimated adult fish counts at the entrance of the Columbia River to the Pacific Ocean); harvest rates for tributaries based on Lower Granite Dam escapement (estimated adult fish counts passing over Lower Granite Dam); and numbers of spawners. Results are reported in 5-year increments starting with Year 5, i.e., 5 years after an alternative is implemented. The PATH analyses directly incorporated potential effects of key uncertainties. Each action was analyzed across a range of assumptions reflecting alternative biological considerations, survival responses, and variations in future climate effects. As a result, the projected effects of any given action on Snake River salmon runs generated by the PATH analyses were not simple point estimates. Summary statistics were used to compile possible combinations of key assumptions across the large number of model runs. In

addition to expressing projections in terms of numbers of fish. PATH also summarized results in the context of the relative probability of exceeding survival and recovery criteria. Projected numbers of fish and harvest were summarized in terms of a standard set of fractions or percentiles of the total number of combinations run for each action (10th, 25th, 50th, 75th and 90th percentiles). If the harvest reported at the 25th percentile was 100 fish, for example, that meant that 25% of the model runs for that particular action resulted in a harvest of 100 fish or less. If, for that same action, the harvest reported at the 75th percentile was 500, that meant that 75% of the runs for that action resulted in a projected harvest of 500 or less.

In order to analyze the economic effects of future harvests under the different alternatives, the DREW Anadromous Fish Workgroup expanded the PATH results to represent all Snake River wild and hatchery stocks. This required that study assumptions be made for certain additional life-cycle modeling factors beyond those included in the PATH process. A generalized life-cycle representation for Snake River salmonids is presented as Figure 3.5-1.

The assumptions used to expand PATH results should not be considered an attempt to develop a separate life-cycle model. Wherever possible, PATH modeling factors were reused as proportions in the expansion methods. The assumptions for the life-cycle modeling factors are shown by species in Table 3.5-1.

3.5.2.1 Smolt-to Adult Return Rates

Salmon and steelhead typically reproduce in fresh water and spend a greater part of their adult life in the ocean. In their migratory route, they are exposed to a variety of predators. Survival rates from production to harvest are important components of how many adult fish will be available for harvest. PATH forecasts were presented in 5-year increments, starting with Year 5 and ending with Year 100 and did not include SARs.

In order to extend the PATH information to all Snake River stocks, it was necessary to identify the Year zero run size information and identify the SARs for the modeled runs. This was necessary to identify the changes PATH projected between Years zero and 5. These ratios of change could then be applied to the other wild and hatchery stocks. Based on information from Beamesderfer et al. (1997) and the Technical Advisory Committee (TAC), the seven spring/summer chinook index stocks modeled by PATH accounted for 52 percent of all wild stocks from 1986 to 1995. The 10-year averages from 1986 to 1995 were adopted to provide the missing Year zero information for run size, SARs, and harvest rates.

Historical information was available on the survival of hatchery-reared salmon and steelhead releases and some test wild-reared anadromous fish. A survival rate was defined for the purposes of this analysis as total hatchery releases divided by the number of adults that subsequently appear in fisheries or in hatchery returns. Recent hatchery practices have mainly released fish at smolt age. Therefore, survival rates are identified as smolt-to-adult survival rates or SARs in this analysis. The 10-year average SARs (1986 to 1995) for hatchery stocks were 0.25 percent for spring/summer chinook, 0.6 percent for fall chinook, and 0.8 percent for summer steelhead. Survival rates for wild-origin fish can be calculated in a similar manner as total downstream migrating smolts divided by the number of fish harvested plus spawner escapement totals. The SAR rates used for this economic analysis differ somewhat from rates used in the

Table 3.5-1. Additional Biological Assumptions Needed to Expand PATH Results for Use in the Anadromous Fish Economic Analysis

Life-Cycle/Modeling Factors	Spring/Summer Chinook	Fall Chinook	Summer Steelhead
Smolt downstream passage mortality	Nan	Nan	Nan
Ocean incidental mortality	Nan	Nan	Nan
Ocean harvest	Nan	PATH results	Nan
Run size total—wild	For Year 0, 1986-95 average from Table 2, Tab 1 and 2, TAC (1997). Future years calculated at the same percentage change as PATH results for index stock's ocean escapement. PATH results ocean escapement calculated using mainstem harvest divided by mainstem harvest rates.	For Year 0, 1986-95 average from Table 9, Tab 3, TAC (1997).	For Year 0, 1986-95 average (length method) for A and B runs Tables 12 and 13, Tab 8, TAC (1997). Future years, 37% s/s chinook SAR changes.
Run size total—hatchery	Nan	Nan	Nan
Total adults—wild	Mainstem harvest + tributary harvest + pre-spawning mortality after LWG + spawners	Total harvest + spawners + hatchery supplements. Pre-spawning mortality assumed to be zero.	Mainstem harvest + tributary harvest + pre-spawning mortality after LWG + spawners
Total adults—hatchery	For Year 0, hatchery smolt production goals in 1998 from Smith (1998) times SAR recent year averages in various CWT Missing Production Group Annual Reports (Fuss et al. 1994 and Garrison et al. 1995). For future years, hatchery production held constant and hatchery SAR same changes as wild SAR.	For Year 0, hatchery smolt production goals in 1998 from Smith (1998) times SAR recent year averages in various CWT Missing Production Group Annual Reports (Fuss et al. 1994 and Garrison et al. 1995). For future years, hatchery production held constant and SAR same changes as wild SAR.	For Year 0, hatchery smolt production goals in 1998 from Smith (1998) times SAR recent year averages in various CWT Missing Production Group Annual Reports (Fuss et al. 1994 and Garrison et al. 1995). For future years, hatchery production held constant and SAR same changes as 37% wild spring/summer chinook SAR.
Mainstem harvest—wild	For Year 0, same proportion as PATH results index stocks. For future years, PATH results expanded to represent total production.	For Year 0, Table 9, Tab 3, TAC (1997). For future years, PATH results.	Table 12 and 13, Tab 8, TAC (1997).

Table 3.5-1. Additional Biological Assumptions Needed to Expand PATH Results for Use in the Anadromous Fish Economic Analysis

Continued

Life-Cycle/Modeling Factors	Spring/Summer Chinook	Fall Chinook	Summer Steelhead
Mainstem harvest—hatchery	Proportion of PATH results for mainstem harvest to total wild adults.	Proportion of PATH results for mainstem harvest to total wild adults.	Table 12 and 13, Tab 8, TAC (1997).
Tributary harvest—wild	PATH results expanded to represent total production.	PATH results	Table A1d, Tab 8, TAC (1997).
Tributary harvest—hatchery	Proportion of PATH results for index stock's tributary harvest to total wild adults	Nan	Table A1d, Tab 8, TAC (1997).
Upstream passage mortality	Nan	Nan	Nan
LWG Dam escapement—wild	(tributary harvest + spawners) ÷ 0.9. The 10% LWG prespawning mortality factor is from Marmorek (personal communication 1999).	Tributary harvest + spawners + supplements, i.e., zero assumed pre-spawning mortality.	For Year 0, 1986-95 average (length method) for A and B runs, Table 12, Tab 8, TAC (1997). Future years calculated as same percentage change as PATH results calculated LWG escapement
LWG Dam escapement—hatchery	Nan	Nan	Nan
Pre-spawning mortality—wild	10% of LWG escapement	Zero assumed pre-spawning mortality.	10% of LWG escapement
Female fraction fecundity—wild and hatchery	Female fraction 50% and fecundity 3,500	Female fraction 50% and fecundity 3,500	Female fraction 50% and fecundity 2,500
Smolt capacity and egg survival rates—wild	Smolt carrying capacity and density dependent egg-smolt survival rate	Smolt carrying capacity and density dependent egg-smolt survival rate varying from 15% in Year 5 to 2% in Year 25+	Varying from 15% in Year 5 to 2% in Year 25+
Smolt capacity and egg survival rates—hatchery	67% fecundity	67% fecundity	67% fecundity

1/ Nan—No assumption needed; SAR—smolt-to-adult survival rate; CWT—coded wire tag; LWG Dam—Lower Granite Dam.

2/ Fecundity is the number of fertilized eggs that can be attributed to a spawning pair.

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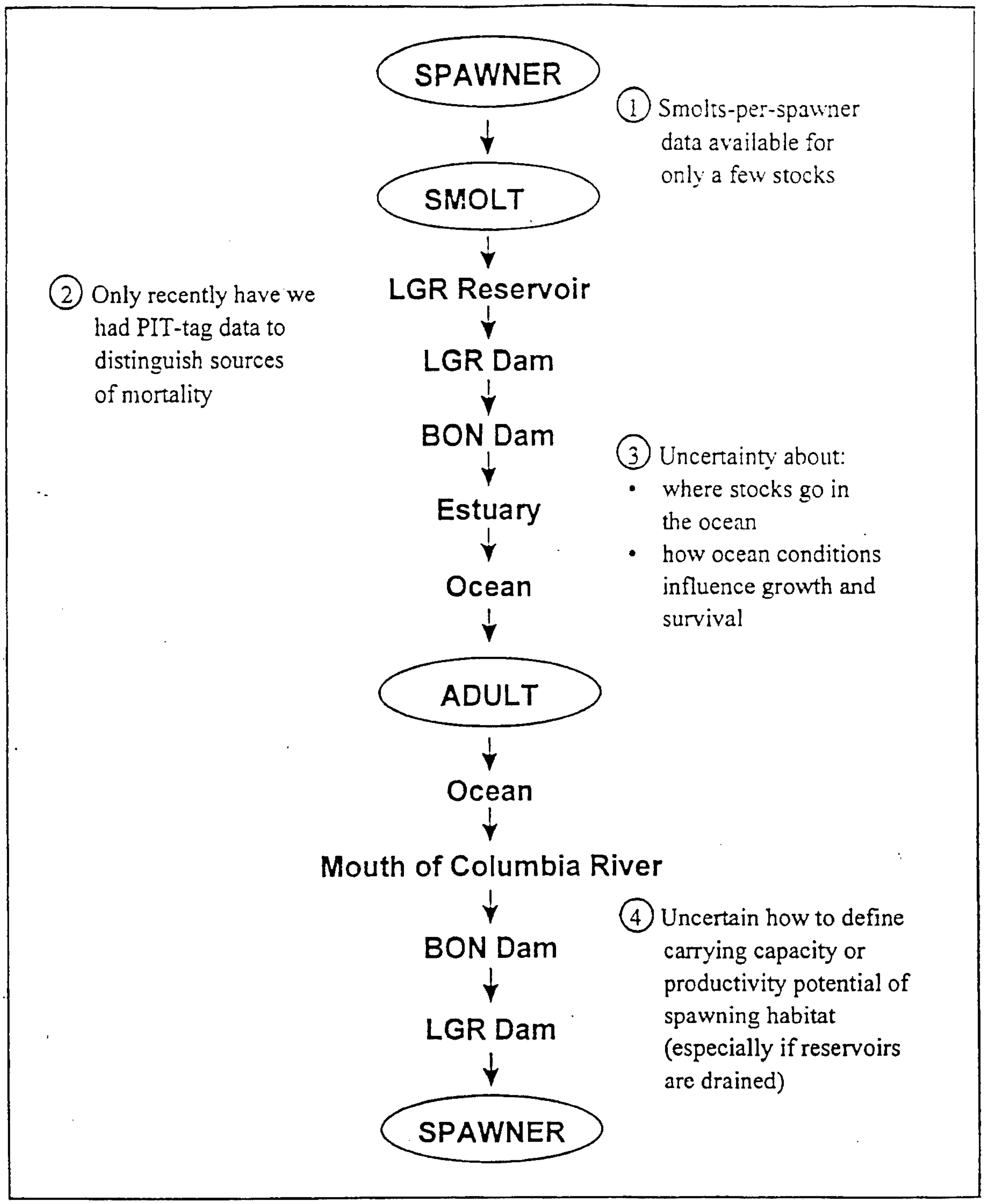


Note: Annotations show examples of points in the life cycle where empirical data are missing or incomplete.
Source: NMFS (1999).

Figure 3.5-1. Straight-line Representation of a Generalized Life-cycle for Snake River Salmonids

simulation modeling conducted by PATH. The definition change was needed to align expressions of wild adult returns with those reported in other publications for hatchery adult returns.

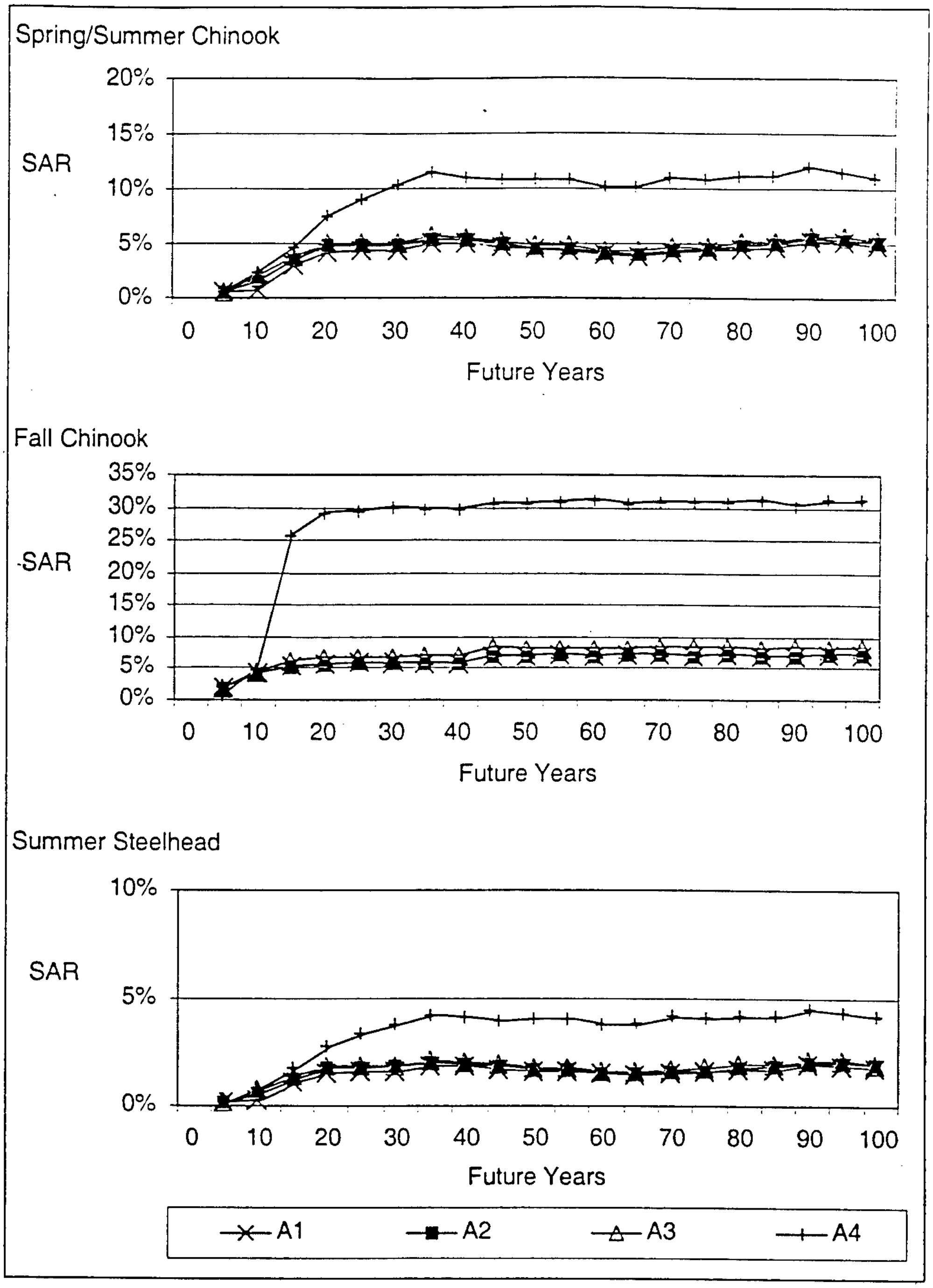
Indicator SAR rates were calculated for the PATH wild stocks by dividing the number of harvested fish plus spawner escapement totals by the number of smolts produced 5 years earlier. The number of smolts were calculated using a density-dependent. egg-to-smolt relationship applied to the number of spawners identified that year. These rates were then applied to all wild Snake River stocks and modeled for each alternative. The results of this modeling are presented graphically in Figure 3.5-2. The PATH indicator SAR rate of change was also used to identify the change in hatchery SARs from Year zero onward.

3.5.3 Allocation to Fisheries

There are three basic distribution patterns of Columbia River Basin produced salmon: north-turning fish (fall chinook), south-turning fish (coho), and some that tend to migrate in either direction (some of the above). Steelhead tend to scatter and migrate as on far as Russian waters. Harvest rates by geographic area depend on migration patterns, as well as on historic fishing patterns, and on international and historic treaties and management policies. The same reports used in calculating survival rates are used to calculate historic geographic and gear harvest shares. The distributional assumptions used for this economic analysis are that future harvests will reflect recent historical catches. These assumptions, however, depend on present Columbia River, U.S.-Canada, and Indian treaty allocations. Harvest allocation treaties change. The PST was being renegotiated at the time of this analysis. As a result, this analysis uses existing U.S. and Indian tribal agreements as the base for allocating harvests. What may be available after these obligations are met is distributed according to historical harvest distributions.

The economic effects of changing anadromous harvest depend on the user group and the geographic area where harvest takes place. Table 3.5-2 shows the 1986 to 1995 average in-river harvest rates, based on run size measured at ocean escapement. The in-river and ocean user group distributions used in the modeling are shown in Table 3.5-3. These tables must be carefully interpreted if compared, because of the basis of the shares. Treaty rights are for 50 percent of the harvestable fish, regardless of the geographic area. Treaty harvests have consistently fallen below the treaty right share for composite (wild and hatchery) Snake River summer steelhead. To provide a realistic transition to this distribution, a 25-year trend was used. This means that summer steelhead recreational mainstem (about 10,000 fish) and tributary harvest (about 40,000 fish) are held relatively constant during the 25-year transition period. After the transition period, both treaty and recreational harvests grow proportionally.

Run sizes can be measured at ocean escapement or at other geographic locations. The major anadromous fish stock's wild-origin run size measured at escapement past the uppermost dam on the lower Snake River over a recent historical period (1964-1996) and forecasts over the first 50 years of project life for each alternative are shown in Figures 3.5-3 through 3.5-6. Ocean and in-river harvests as well as other river passage mortalities have been accounted for in the wild run sizes. The forecasts show rapid recovery during the early project period and minor fluctuations in later years. These fluctuations, as explained by PATH documentation, are due to ocean regime shifts. The forecasted wild origin-run sizes are less than about one-third of the pre-dam historical levels.



Notes:
1. The Y-axis maximums are different for each species.
2. Smolt-to-adult rates are referenced as indicators because they are not based on age structures. The indicator rates are spawners, prespawning mortality, and harvest divided by smolts produced 5 years earlier and expressed as a percent. Smolts are calculated using a density-dependent, egg-to-smolt relationship and the number of spawners 5 years earlier.
3. Summer steelhead rates are based on changes to spring/summer chinook changes.
4. A1 through A4 refer to Alternatives 1 through 4

Figure 3.5-2. Snake River Wild-Origin Fish Smolt-to-Adult Survival Rate Indicators by Alternative during Project Period

Table 3.5-2. Snake River Anadromous Fish In-river Harvests and Harvest Rates for 10-year Average, 1986-1995

		Existing Inriver Harvest and Harvest Rates										
		Mainstem						Tributary				
		Commercial Non-Treaty		Recreational		Treaty Indian		LWG Escapement		Tributary Recreational		
Species/Stock	Ocean Escapement	Number	Rate	Number	Rate	Number	Rate	Number	Rate	Number	Rate	
Snake River												
Fall Chinook												
Wild	1,813	—	—	—	—	419	23.1%	381	21.0%	—	—	
Hatchery	4,458	—	—	—	—	1,108	24.9%	1,679	37.7%	—	—	
Total	**6,271**	**803**	**12.8%**	**159**	**2.5%**	**1,527**	**24.3%**	**2,060**	**32.8%**	—	—	
Spring Chinook												
Wild	8,657	—	—	—	—	561	6.5%	5,126	59.2%	—	—	
Hatchery	19,865	—	—	—	—	1,363	6.9%	12,234	61.6%	—	—	
Total	**28,522**	**506**	**1.8%**	**364**	**1.3%**	**1,924**	**6.7%**	**17,360**	**60.9%**	—	—	
Summer Chinook												
Wild	3,073	00.0%	—	—	78	2.5%	2.5%	2,294	74.6%	—	—	
Hatchery	2,856	00.0%	—	—	89	3.1%	3.1%	1,972	69.0%	—	—	
Total	**5,929**	**00.0%**	**3**	**0.0%**	**167**	**2.8%**	**2.8%**	**4,265**	**71.9%**	—	—	
Summer Steelhead												
Wild	21,187	0	0.0%	0	0.0%	4,115	19.4%	16,225	76.6%	0	0.0%	
Hatchery	105,598	0	0.0%	10,733	10.2%	25,972	24.6%	72,795	68.9%	40,248	38.1%	
Total	**126,785**	**0**	**0.0%**	**9,846**	**7.8%**	**29,636**	**23.4%**	**89,020**	**70.2%**	**40,248**	**31.7%**	

Note:

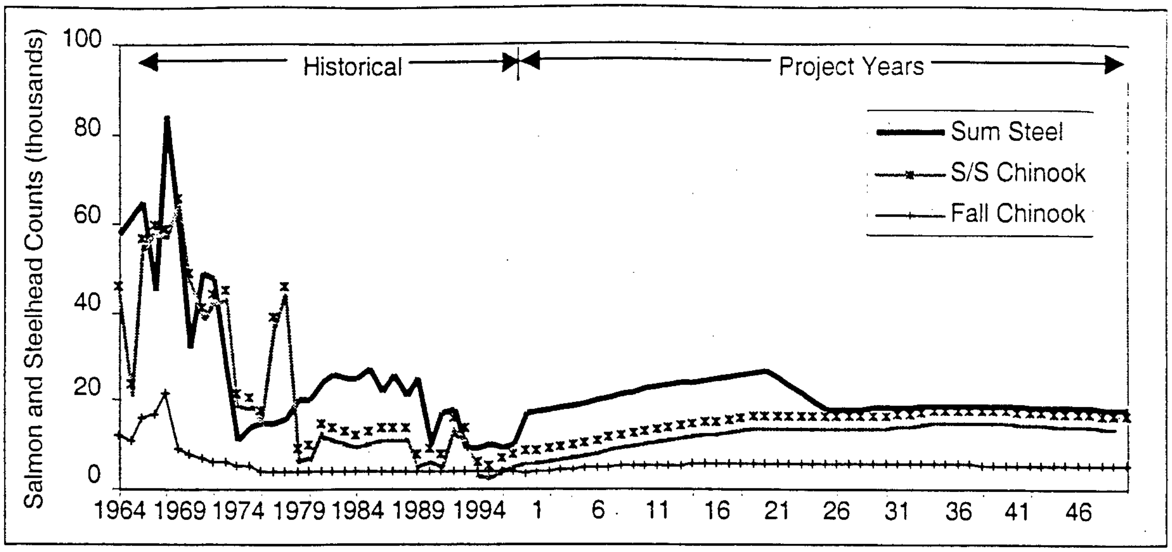
1. Averages are based on 1986 through 1995 period.
2. Harvest rates are based on ocean escapement.
3. Upriver refers to mainstem escapement from the lower Columbia River into either the Upper Columbia River or the Snake River.
4. All references to specific tables and tabs are found in TAC 1997.
5. Recreational mainstem and tributary harvests are assumed to be illegal and zero for wild fall chinook, spring chinook, and summer chinook after 1990 and for summer steelhead after 1984.
6. Fall chinook
   a. Total fall chinook harvest from commercial, recreational, and treaty user groups is from Table 8, Tab E.??? The assumption is made that catch in zone 6 is treaty.
   b. Ocean and Lower Granite Dam escapement is from Tables 8 and 9, Tab 3.
   c. Treaty harvest of wild fall chinook is from Table 9, Tab 3. Hatchery harvest is the residual of total and wild salmon.
7. Spring chinook
   a. Total ocean escapement is the total upriver run size times and the proportion of Snake River spring chinook from Tables 1 and 2, Tab 1.
   b. Wild ocean escapement and LWG escapement are from Tables 2 and 3, Tab 1.
   c. Hatchery LWG escapement is from Table 3, Tab 1.
   d. Total commercial and total recreational Snake River harvests are estimated using upriver spring chinook mainstem harvests by user group and applying the proportion of mainstem escapement to Snake River.
   e. Treaty harvest of wild mainstem Snake River spring chinook is from Table 2, Tab 1. It is assumed that harvests in zone 6 are treaty harvest only. Total harvest is estimated using harvest of upriver spring chinook and a proportion of Snake River spring chinook. Treaty harvest of hatchery spring chinook is the residual of total and wild fish.
8. Summer chinook
   a. Wild ocean escapement and LWG escapement are from Table 2, Tab 2.
   b. Hatchery ocean escapement and LWG escapement are from Table 3, Tab 2.
   c. Total recreational mainstem harvest of summer chinook is estimated from harvest of upriver summer chinook and a proportion of Snake River summer chinook.
   d. Non-treaty commercial harvest in zones 1-5 for wild and hatchery summer chinook is zero. Table 1, Tab 2. Incidental non-retention is excluded.
   e. Treaty harvest of wild summer chinook is from Table 2. Tab 2. This assumes zone 6 harvest is treaty-only.
   f. Treaty harvest of hatchery summer chinook is from Table 3, Tab 2. This assumes zone 6 harvest is treaty-only.
9. Summer steelhead
   a. Non-treaty commercial harvest is assumed to be zero.
   b. LWG escapement is from Tables 12 through 15, Tab 8. Lower Granite counts of group A and B were summed (based on the length method).
   c. Total tributary harvest is from Tables A1c and A1d.
   d. Wild hatchery ocean escapement is from Tables 12 through 15, Tab 8. Lower Granite with no mainstem fishery counts of group A and B were summed (based on the length method). This provides a minimum run size.
   e. Mainstem harvest rates are assumed to equal mainstem harvest rates for total upriver summer steelhead stocks.

Source: TAC 1997.

Table 3.5-3. Assumptions for Anadromous Fish User Group Distributions by Species and Geographic Area

Geographic Area/User Group	Anadromous Species: Chinook Spring/Summer	Chinook Fall	Summer Steelhead
Ocean Harvest			
Alaska			
a) Commercial	0.000%	11.663%	0.000%
b) Sport	0.000%	0.002%	0.000%
British Columbia			
a) Commercial	0.000%	48.506%	0.000%
b) Sport	0.000%	3.880%	0.000%
Subtotal Alaska/B.C.	0.000%	64.051%	0.000%
Washington ocean			
a) Commercial	0.000%	19.027%	0.000%
b) Sport	0.000%	8.456%	0.000%
Washington Puget Sound			
a) Commercial	0.000%	0.002%	0.000%
b) Sport	0.000%	0.002%	0.000%
Oregon			
a) Commercial	0.000%	6.343%	0.000%
b) Sport	0.000%	2.115%	0.000%
California			
a) Commercial	0.000%	0.002%	0.000%
b) Sport	0.000%	0.002%	0.000%
Subtotal WOC Ocean	0.000%	35.949%	0.000%
Subtotal Ocean	0.000%	100.000%	0.000%
In-river Harvest			
Treaty Year 0	50.000%	62.219%	37.200%
Year 5	50.000%	62.219%	39.760%
Year 10	50.000%	62.219%	42.320%
Year 15	50.000%	62.219%	44.880%
Year 20	50.000%	62.219%	47.440%
Year 25-100	50.000%	62.219%	50.000%
Non-treaty			
Mainstem	(less treaty)		(less treaty)
a) Freshwater sport	77.000%	2.874%	100.000%
b) Commercial non-treaty	17.000%	34.491%	0.000%
c) Other in-river Tributary	6.000%	0.416%	0.000%
Tributary			
a) Freshwater sport	100.000%	0.000%	100.000%
Returns to Hatcheries			
Requirement to Carcass	100.000%	100.000%	100.000%
Surplus			
a) Carcass and egg sales	50.000%	50.000%	50.000%
b) Food fish	50.000%	50.000%	50.000%

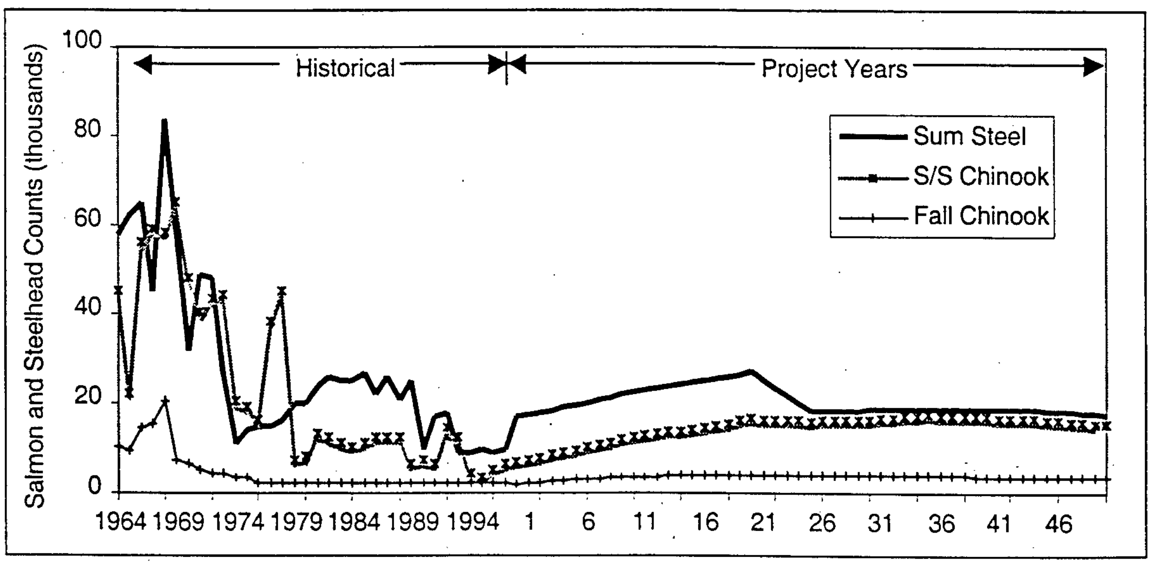
1/ Expressed as percent of fish harvested by the geographical fisheries.
2/ Results assume 50% for treaty harvests and zero ocean harvests for spring/summer chinook and summer steelhead.
3/ Treaty harvest percent of fish is based on all in-river harvestable fish (mainstem and tributary). It is assumed that all treaty harvests are in the mainstem.
4/ Non-treaty mainstem harvests for spring/summer chinook and summer steelhead represent the distribution of the remaining mainstem harvestable fish by user group.
5/ Non-treaty harvests for fall chinook represent shares of total in-river harvest.



Note: Adult wild salmon and steelhead counts at the uppermost dam on the Snake River below Lewiston (Ice Harbor Dam 1964-68, Lower Monument Dam 1969, Little Goose Dam 1970-74, Lower Granite Dam 1970-74).

Source: DREW Anadromous Fish Workgroup, 1999, and IDFG (1998).

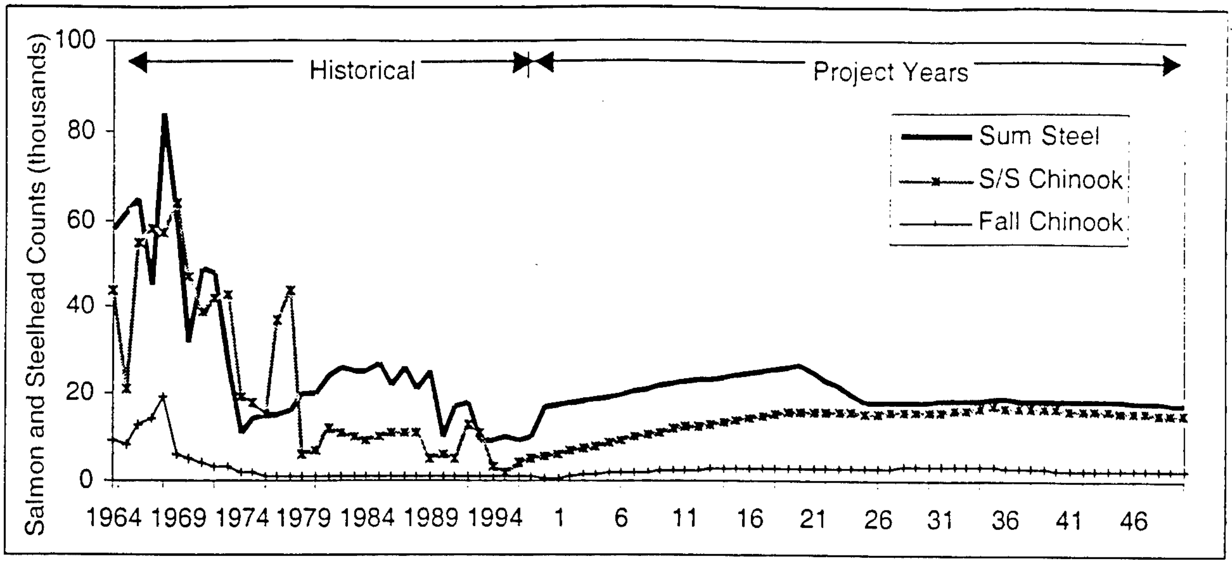
Figure 3.5-3. Historical and Project Year Wild-Origin Stock Run Counts at Snake River Uppermost Dam, Alternative 1, Existing Conditions



Note: Adult wild salmon and steelhead counts at the uppermost dam on the Snake River below Lewiston (Ice Harbor Dam 1964-68, Lower Monument Dam 1969, Little Goose Dam 1970-74, Lower Granite Dam 1970-74).

Source: DREW Anadromous Fish Workgroup, 1999, and IDFG (1998).

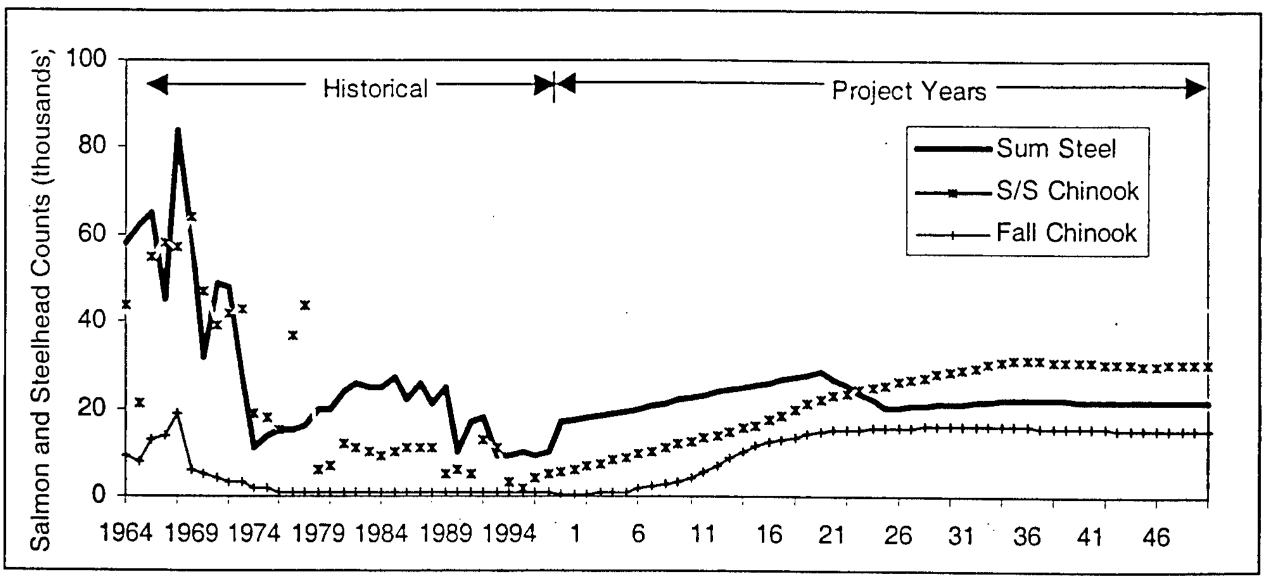
Figure 3.5-4. Historical and Project Year Wild-Origin Stock Run Counts at Snake River Uppermost Dam, Alternative 2, Maximum Transport of Juvenile Salmon



Note: Adult wild salmon and steelhead counts at the uppermost dam on the Snake River below Lewiston (Ice Harbor Dam 1964-68, Lower Monument Dam 1969, Little Goose Dam 1970-74, Lower Granite Dam 1970-74).

Source: DREW Anadromous Fish Workgroup, 1999, and IDFG (1998).

Figure 3.5-5. Historical and Project Year Wild-Origin Stock Run Counts at Snake River Uppermost Dam, Alternative 3, Major System Improvements



Note: Adult wild salmon and steelhead counts at the uppermost dam on the Snake River below Lewiston (Ice Harbor Dam 1964-68, Lower Monument Dam 1969, Little Goose Dam 1970-74, Lower Granite Dam 1970-74).

Source: DREW Anadromous Fish Workgroup, 1999, and IDFG (1998).

Figure 3.5-6. Historical and Project Year Wild-Origin Stock Run Counts at Snake River Uppermost Dam, Alternative 4, Dam Breaching

3.5.4 Economic Evaluation

The overall goal of this analysis is to calculate the economic values from harvesting those Columbia and Snake River anadromous fish stocks that are affected by the proposed alternatives. The results of this analysis are presented in terms of net economic value. Net economic value usually defines the value that someone, some group, or the nation may receive from an activity, over and above the cost of that activity. Both economic value and regional economic impacts are calculated over a 100-year project life. Annualized future values are discounted to Year zero using various interest rates. The current Corps rate is 6.875 percent, while the current Bonneville Power Administration (BPA) rate is 4.75 percent. Indian tribes generally do not discount future generation benefits, i.e., they use a zero percent interest rate. Values are annualized using the Corps definition for annual average equivalent values. All values are in 1998 dollars.

Values calculated on a per-fish basis differ, depending on the type of harvest. Commercial economic values or NED benefits are based on ex-vessel values. Seventy percent of ex-vessel revenue is used as an indicator of net economic value. Commercial fishing economic data were compiled about ex-vessel values (price paid to harvesters for their catch), primary processing prices, recovery rates, and costs of harvesting and processing for different species, gear, geographic areas, and user groups. Anadromous fish from the Snake River are commercially harvested by different means (troll—hand and power; net—gillnet, purse seine, and dip net) in different ocean areas (southeast Alaska, Canada, Washington, Oregon, and northern California), the Columbia River estuary, the main stem of the Columbia River, and its main tributaries. Primary seafood processing is included to evaluate the contribution at different stages of processing. For example, troll salmon are usually dressed and sold directly to processors. Net fish are usually sold to a fish buyer in the round. A tender, for a margin of 10 to 18 cents per pound, gathers the salmon and delivers them to the processors. Hatchery fish that escape harvesting return as hatchery surpluses. The surpluses are sold for eggs, carcasses, and sometimes food fish. The funds are usually returned to hatcheries to offset operating and capital improvement costs.

The recreational fishery value uses a benefit transfer approach to develop a value per angler day. This value is then multiplied by the number of angler days required to catch a fish. Available information on recreational fishing (success rates and trip expenditure patterns by trip mode, such as guided trips, etc.) associated with lower Snake River anadromous fish runs was compiled and synthesized. Angler days were determined using catch per unit effort (CPUE) data based on recent periods, which were then adjusted for abundance levels. The CPUE to determine angler days used recent period catch rates. Ocean recreational composite CPUE rates are 1 day per fish, Columbia River mainstem is 2 days per fish, and Snake River tributary is 5.88 days per fish. CPUE is influenced by fishing motivational factors and fishery management techniques. For example, all existing recreational steelhead fishing is selective for hatchery origin fish. If future wild-origin abundance levels allowed retention, then the CPUE (expressed as days per fish) would decrease. Modeling assumptions for CPUE incorporated decreasing tributary CPUE (expressed as days per fish) with increasing abundances. Economic value assumptions are presented for commercial and recreational fishing by species and fishery in Table 3.5-4.

The direct costs of commercial and recreational fishing and hatchery surplus sales were then related to economic values for the national economy. The changes in NED values associated with changes in anadromous fish harvest were calculated as annual average values over a 100-year period of analysis and presented as net of the base case (Alternative 1, Existing Conditions). These annual

Table 3.5-4. Economic Value (NED Benefits) Assumptions by Species and Fishery

Spring/Summer Chinook	Commercial	Recreational
Ocean		
Alaska	33.83	
British Columbia	34.30	
Washington ocean	23.68	
Washington Puget Sound	21.19	
Oregon	21.65	
California	22.33	
Columbia Basin inland		
Mainstem	49.95	51.43
Tributary		63.23
Other	0.00	
Food fish	26.87	
Carcass and egg sales	0.00	
Fall Chinook		
Ocean		
Alaska	33.83	51.43
British Columbia	34.30	51.43
Washington ocean	23.68	51.43
Washington Puget Sound	21.19	51.43
Oregon	21.65	51.43
California	22.53	51.43
Columbia Basin inland		
Mainstem	23.53	51.43
Tributary		
Other	0.00	
Food fish	18.25	
Carcass and egg sales	1.23	
Summer Steelhead		
Ocean		
Alaska		
British Columbia	11.44	
Washington ocean		
Washington Puget Sound		
Oregon		
California		
Columbia Basin inland		
Mainstem	9.99	52.85
Tributary		63.23
Other		
Food fish	8.73	
Carcass and egg sales	1.23	

1/ Average 1998 dollars per fish (commercial fisheries) and angler day (recreational fisheries).

2/ Carcass sales assume $0.10 per pound for whole body dressed weight.

average values were presented for Alternatives 2 through 4 using three different discount rates in Table 3.5-5. Using a 6.875 percent discount rate. NED benefits ranged from $0.16 million for Alternatives 2 and 3 to $1.59 million for Alternative 4. Dam Breaching. If a zero discount rate were used, the average annual benefits might reach $3.49 million. Most of the totals shown here would be generated from the in-river treaty fishery contributed by fall chinook. There would also be significant NED benefits associated with the in-river recreational fishery. These benefits are addressed in the analysis conducted by the DREW Recreation Workgroup (see Section 3.2). To give a more complete depiction of the sensitivity associated with data and modeling assumptions, the in-river recreational user group is included in the risk and uncertainty analysis presented in Section 3.5.5.

Table 3.5-5. Changed Annualized Economic Value (NED Benefits) Between Base Case and Other Hydrosystem Actions for Various Discount Rates (1998 dollars)

	Discount Rates					
	0%		4 6/8%		6 7/8%	
Alternative	Amount	Order	Amount	Order	Amount	Order
Annual Average Equivalent Value (Year zero to Year 100)						
2	$0.20	2	$0.18	2	$0.16	3
3	$0.19	3	$0.17	3	$0.16	2
4	$3.49	1	$2.06	1	$1.59	1

1/ NED benefits measured by annual average equivalent values over a 100-year project life in millions of 1998 dollars. Alternatives 2 through 4 are presented net of the base case (Alternative 1, Existing Conditions)

2/ Evaluation is for all modeled anadromous fish species and includes harvests and hatchery surplus use. The evaluation excludes the economic values for in-river recreational fishing.

3/ The analysis is based on PATH results' "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook using "likely" (50th percentile) modeling output.

Average annual NED values are presented by species for wild- and hatchery-origin fish in Table 3.5-6. Values for presented for each alternative using "low," "likely," and "high" modeling results that correspond to PATH results for 25th, 50th, and 75th percentile modeling outputs, respectively. The average annual values were calculated using a 6.875 percent discount rate.

3.5.5 Risk and Uncertainty

The economic values from the Columbia River Basin anadromous fish runs are determined using forecasted harvests throughout their migration routes. The actual harvestable fish depends on the productivity of the inland water system, as well as the ocean system. Inland water system production factors can include harvesting methods, habitat alterations, hatchery production, hydrosystem operations, and ocean conditions. Strategies for recovery can address manmade factors, the more immediate remedies being harvesting methods, hydrosystem operations, and hatchery production. A short discussion of the variability in economic analysis results due to these factors is presented below. These factors are addressed in terms of markets, smolt-to-adult survival rates, and harvest management. Additional sections in this chapter discuss how the economic analysis results change based on using different PATH scenarios.

Table 3.5-6. Ranges of Annualized Economic Value (NED Benefits) by Fishery For Each Hydrosystem Action Using "Low," "Likely," and "High" Modeling Results (1998 dollars) ($1000s)

	Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Anadromous Fish	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Commercial												
Ocean												
Alaska	$6.15	$12.72	$26.35	$6.15	$12.72	$26.35	$6.85	$14.56	$30.54	$31.99	$69.48	$136.12
British Columbia	$25.93	$53.66	$111.09	$25.93	$53.66	$111.09	$28.90	$61.41	$128.77	$134.89	$292.97	$573.99
WA Ocean	$7.02	$14.53	$30.08	$7.02	$14.53	$30.08	$7.83	$16.63	$34.87	$36.53	$79.34	$155.44
WA Puget Sound	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01	$0.01
Oregon	$2.14	$4.43	$9.17	$2.14	$4.43	$9.17	$2.39	$5.07	$10.63	$11.13	$24.18	$47.38
California	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.00	$0.01	$0.02
Subtotal Ocean	$41.24	$85.34	$176.70	$41.24	$85.34	$176.70	$45.97	$97.68	$204.82	$214.55	$465.99	$912.95
Inriver												
Non-treaty	$21.50	$45.76	$96.49	$23.09	$51.36	$110.14	$24.26	$52.75	$113.84	$120.47	$223.36	$409.35
Treaty Indian	$293.52	$702.77	$2,003.61	$323.81	$795.22	$2,062.65	$323.18	$789.90	$1,992.09	$564.64	$1,287.11	$2,771.28
Hatchery Returns	$8.77	$137.06	$522.24	$28.98	$198.78	$613.34	$25.47	$188.48	$567.35	$206.31	$480.92	$990.32
Subtotal Inriver	$323.79	$885.59	$2,622.34	$375.88	$1,045.36	$2,786.14	$372.92	$1,031.12	$2,673.27	$891.43	$1,991.39	$4,170.95
Subtotal Commercial	$365.02	$970.93	$2,799.04	$417.12	$1,130.70	$2,962.84	$418.89	$1,128.80	$2,878.09	$1,105.97	$2,457.38	$5,083.90

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Table 3.5-6. Ranges of Annualized Economic Value (NED Benefits) by Fishery For Each Hydrosystem Action Using "Low," "Likely," and "High" Modeling Results (1998 dollars) ($1000s) Continued

	Alternative 1			Alternative 2			Alternative 3			Alternative 4		
Anadromous Fish	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**	**Low**	**Likely**	**High**
Recreational												
Ocean												
Alaska	$0.00	$0.00	$0.01	$0.00	$0.00	$0.01	$0.00	$0.00	$0.01	$0.01	$0.02	$0.04
British Columbia	$3.11	$6.44	$13.32	$3.11	$6.44	$13.32	$3.47	$7.37	$15.44	$16.18	$35.14	$68.84
WA Ocean	$6.78	$14.03	$29.04	$6.78	$14.03	$29.04	$7.55	$16.05	$33.66	$35.26	$76.58	$150.04
WA Puget Sound	$0.00	$0.00	$0.01	$0.00	$0.00	$0.01	$0.00	$0.00	$0.01	$0.01	$0.02	$0.04
Oregon	$1.70	$3.51	$7.26	$1.70	$3.51	$7.26	$1.89	$4.02	$8.42	$8.82	$19.15	$37.53
California	$0.00	$0.00	$0.01	$0.00	$0.00	$0.01	$0.00	$0.00	$0.01	$0.01	$0.02	$0.04
Subtotal Ocean	$11.59	$23.98	$49.65	$11.59	$23.98	$49.65	$12.92	$27.44	$57.55	$60.28	$130.93	$256.51
Total Commercial and Recreational	**$376.61**	**$994.91**	**$2,848.68**	**$428.70**	**$1,154.68**	**$3,012.48**	**$431.81**	**$1,156.25**	**$2,935.64**	**$1,166.25**	**$2,588.31**	**$5,340.41**

1/ NED benefits measured by annual average equivalent values over a 100 year project life using 6.875% discount rate in thousands of 1998 dollars.
2/ Evaluation is for all modeled anadromous fish species and includes harvests and hatchery surplus utilization. The evaluation excludes the economic values for in-river recreational fishing.
3/ PATH results fall chinook Action A1 is the same as Action A2. Fall chinook is the only significantly harvested species in ocean fisheries.
4/ "Low," "likely," and "high" modeling results correspond to PATH results for 25th, 50th, and 75th percentile modeling outputs, respectively.
5/ The analysis is based on PATH results' "base case" scenario for fall chinook and "equal weights" scenario for spring/summer chinook.
6/ Total and subtotals may not equal sum of values due to rounding.

The economic value of recreational in-river fisheries calculated by the DREW Anadromous Fish Workgroup are included in the total NED benefits presented in the following sensitivity analysis, since much of the discussion concerns effects of harvest management, and the recreational in-river fishery is the highest contributor to economic values. In-river recreation NED benefits were also calculated by the DREW Recreation Workgroup based on original surveys conducted for this FR/EIS (see Section 3.2). These values are used for the overall NED analysis presented in this document. The values calculated by the DREW Anadromous Fish Workgroup were not included in this analysis to avoid double-counting. Compatibility issues surrounding these two analyses are briefly addressed in Section 3.5.6. The purpose of this risk and uncertainty section is to discuss the sensitivity of the results. Therefore, the change to the fishery's economic value should be relatively proportional, no matter what the estimated value.

3.5.5.1 Markets

Commercial Fishing

For centuries, salmon have sustained the people of the Pacific Northwest. They were an important food source, cultural symbol, and means of trade for American Indians. As western development took place, salmon runs provided jobs and income to harvesters, cannery workers, and related industries throughout the region. As water-based economic development took place in the Pacific Northwest, natural-based production was supplemented by artificial propagation.

Artificial propagation was at first limited to egg incubation. For some salmon species, in order to increase SAR, the propagation process included fry and later-smolt releases. Smolt production may cost $0.50 to $1.00 per smolt. The high cost of smolt production and low overall survival rates of free ranging salmon (salmon ranching) have led to rearing salmon in cages (salmon farming) where smolts will survive at about 80 to 90 percent. The farming process is now providing about 50 percent of the world salmon market. The price of salmon for the fresh and frozen market is now generally set by farmed salmon. These prices depend on markets, but also on the main ingredient in farming salmon, the feed costs. A range of substitutes is available; therefore, no dramatic changes are expected in the price level of commercial salmon produced from the Columbia River Basin.

More variation may be expected in use of a substantial portion of the anadromous fish that return as "surplus" and are not harvested. For wild fish, this presently is not a problem. However, in some cases, returns to hatcheries beyond what is needed for propagation are a resource that could provide additional benefits to the Pacific Northwest region.

According to lower Columbia River processors, about 50 percent of the fall returning fish and 100 percent of the summer returning fish could be used for developed markets (personal communication with processor facility operators, April 1999). Development of markets would include the traditional fresh and frozen markets, as well as value-added products, such as ready-to-purchase fillet steaks and ready-to-eat portions. Other specialty products might also include canned and smoked products. Egg production for the Japanese market might also have a significant potential (Radtke and Davis, 1996).

The model's existing assumptions assume 50 percent of hatchery return surplus goes to egg and carcass sales and 50 percent for food fish. The change in analysis results for hydrosystem actions for developed markets (zero percent carcass sales and 100 percent use for food fish) is about a

$180 thousand or 1 percent gain in average annual NED benefits for Alternative 4, Dam Breaching. Changing the analysis results for a zero percent hatchery utilization results in a $400 thousand loss in average annual NED benefits for Alternative 4, Dam Breaching.

Recreational Angling

Since World War II, there has been a steady increase in outdoor activity in the West. Between 1945 and the early 1970s, recreation activity on public lands grew by more than 10 percent per year, driven by rapid population growth, increased affluence, improvements in cars and interstate highways, decreased real gasoline prices, increased air travel, and the decline of the average work week to 40 hours and 5 days (Walsh 1986). Population growth and the proportion of that population having a degree of affluence are the most significant factors contributing to the increases in recreation activity (English et al. 1993). The significant population increases expected for the West suggest that there may be major increases in recreation activity related to public resources in the future (Haynes and Horne, 1996).

In general, the assumption of one fish per day is used in this evaluation of the benefits of recreational angling in ocean fishing. Past studies of ocean salmon fishing suggest that this success rate is a reasonable representation of historical trends. Since salmon/steelhead fishing has been curtailed inland during the last few years, no clear studies of motivation factors, such as fishing success rates needed to attract anglers, have been completed. The Oregon Department of Fish and Wildlife (ODFW) uses a one-fish-per-day success rate for ocean fishing and up to 2-day-per-fish success rates for inland fishing (Carter, 1999). The State of Idaho conducts annual surveys of anglers (Bowler, 1999). For tributaries above the Columbia River/Snake River confluence, a 2-day-per-fish success rate for wild, non-retained, and hatchery-retained fish has been experienced. For retained steelhead only, the day-per-fish ratio has been 5.88. A study by Reading (1999) suggests that the average success rate for anadromous fish in Idaho is one fish for about 6.5 days of fishing. Future demand for outdoor recreation suggests that a success rate as low as 10 days per fish may be enough to attract anglers to fish for anadromous fish in some inland waters.

Using a range of success rates or CPUE provides a wide range of potential benefits related to the anadromous resources of the Columbia Basin. The change in analysis results for hydrosystem actions is considerable. Changing to a success rate of three days per fish slightly lowers the average annual NED benefits (Table 3.5-7 and Figure 3.5-7), because model assumptions use a tributary summer steelhead CPUE of 5.88 in Year zero trended to a CPUE of 2 over 30 years. Changing the success rate to 10 days per fish increases average annual NED benefits by about double.

3.5.5.2 Smolt-to-Adult Survival Rates

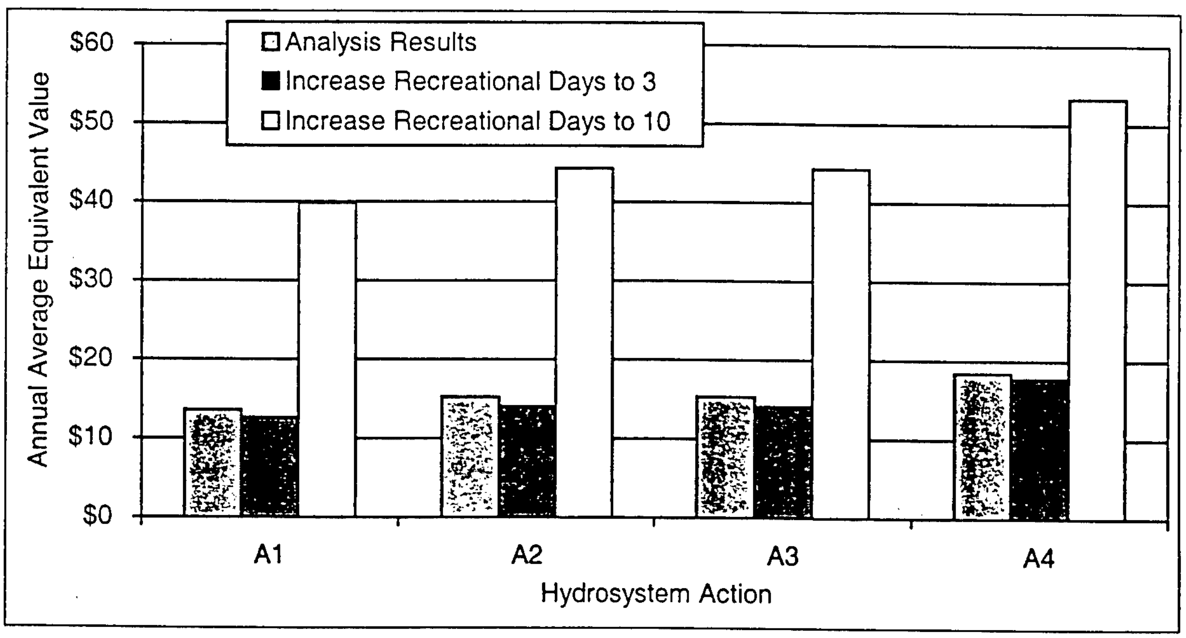
Smolt production and resulting adult harvests are the base for evaluating fishery benefits. The PATH results did not generate SARs as modeled outputs. It was possible to generate an indicator SAR using the 5-year increment outputs of harvests and spawners. These SARs are referenced as indicator rates because insufficient information about age-structures, interdam mortality, and other factors was available to determine a more precise rate. The wild-component indicator SARs by

Table 3.5-7. Annualized Economic Value (NED Benefits) for Alternative Hydrosystem Actions with Different Angler Success Rate Assumptions (1998 dollars)

	Hydrosystem Action			
Category/Alternative	1 ($)	2 ($)	3 ($)	4 ($)
Analysis Results				
AAEV	13.59	15.27	15.33	18.46
Recreational Inland: Success Rate 3				
AAEV	12.64	14.08	14.10	17.78
Difference from analysis results	(0.95)	(1.18)	(1.23)	(0.68)
Recreational Inland: Success Rate 10				
AAEV	39.82	44.25	44.29	53.24
Difference from analysis results	26.22	28.99	28.96	34.78

Note: NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.

AAEV = Average Annual Equivalent Value



Note: NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.

Figure 3.5-7. Annualized Economic Value (NED Benefits) for Alternative Hydrosystem Actions with Different Angler Success Rate Assumptions

species and hydrosystem action are shown in Table 3.5-8. These wild component indicator SARs generally show the large increase necessary to attain the PATH results for forecasted spawners. In general, there must be a sevenfold increase in the indicator SARs for spring/summer chinook and a two to threefold increase for fall chinook between the initial project years and at Year 50 for spawners to be at the level forecast by PATH. Economic values would be significantly affected by a lesser improvement.

3.5.5.3 Harvest Management

Hatchery Production

It is assumed that hatchery management is based on past mitigation agreements and that hatchery release goals are defined by the present NMFS cap on hatchery releases. The role of supplementation hatcheries is not specifically included in the evaluation.

If natural resource-based recreation increases as discussed earlier, a challenge to management may be to convert hatchery surplus to inland recreational angling. The interplay between the conversion of hatchery surplus to recreational fishing and using different CPUE is shown in Table 3.5-9 and Figure 3.5-8. The CPUE, expressed as days per fish, generally decreases with increasing abundances. This is because increasing abundances generally mean harvest management would allow a more liberal bag limit (i.e., five fish per week rather than two). If the CPUE will changed to be slightly lower than the existing analysis, shifting hatchery surpluses would increase average annual NED benefits by about 40 percent.

Table 3.5-8. Wild Smolt-to-Adult Survival Indicator Rates by Species and by Hydrosystem Actions for Selected Project Years

	Survival Rate Indicators	
	Project Year 5 (%)	**Project Year 50 (%)**
Spring/Summer Chinook		
A1	0.468	4.422
A2	0.514	4.495
A3	0.537	4.788
A4	0.557	10.850
Fall Chinook		
A1	1.889	7.195
A2	1.889	7.195
A3	1.877	8.385
A4	0.940	30.850
Summer Steelhead		
A1	0.173	1.636
A2	0.190	1.663
A3	0.199	1.772
A4	0.206	4.014

Note: Project year survival rate indicators are adult spawners and pre-spawning mortality plus harvest divided by smolts produced 5 years earlier expressed as a percent.

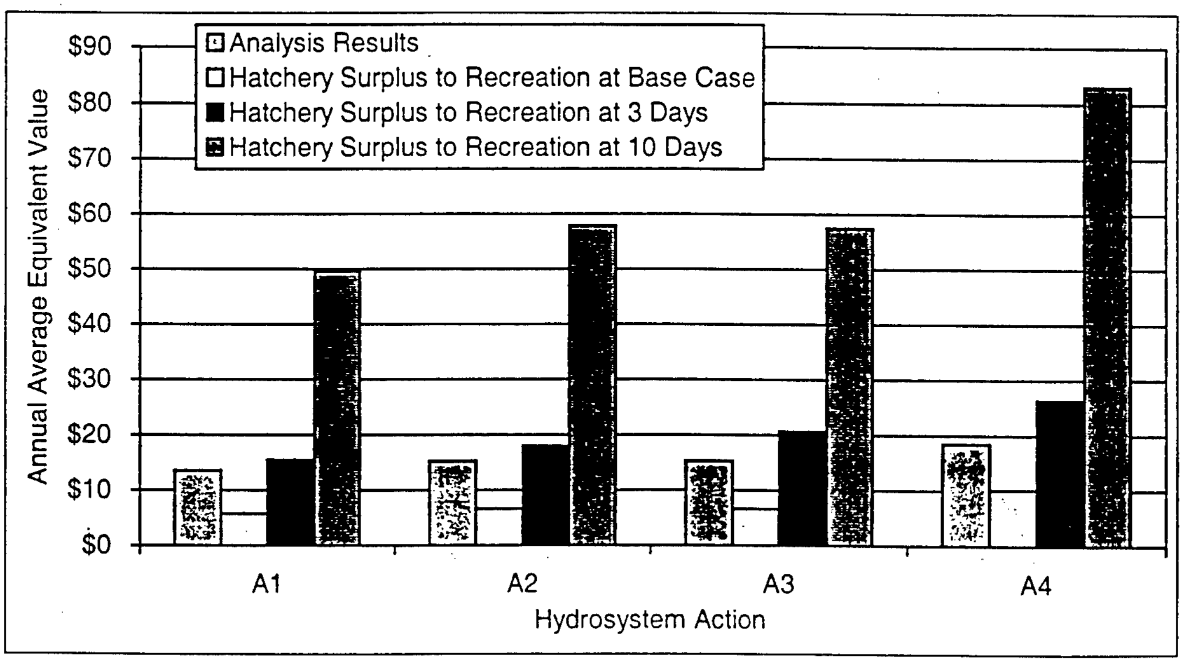
Source: Study and Petrosky and Schaller (1998).

Table 3.5-9. Annualized Economic Value (NED Benefits) for Alternative Hydrosystem Actions with Different Harvest Management Assumptions (1998 dollars)

Category/Alternative	Hydrosystem Action 1 ($)	2 ($)	3 ($)	4 ($)
Analysis Results				
AAEV	13.59	15.27	15.33	18.46
Convert Hatchery Surplus to Inland Recreational: Success Rate 1				
AAEV	5.75	6.66	6.64	10.22
Difference from analysis results	(7.85)	(8.60)	(8.69)	(8.24)
Convert Hatchery Surplus to Inland Recreational: Success Rate 3				
AAEV	15.49	18.04	20.71	26.40
Difference from analysis results	1.90	2.78	5.38	7.94
Convert Hatchery Surplus to Inland Recreational: Success Rate 10				
AAEV	49.59	57.88	57.49	83.05
Difference from analysis results	35.99	42.61	42.16	64.59

Note: NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.

AAEV = Average Annual Equivalent Values



Note: NED benefits measured by annual average equivalent value over a 100 year project life in millions of 1998 dollars.

Figure 3.5-8. Annualized Economic Value (NED Benefits) for Alternative Hydrosystem Actions with Different Harvest Management Assumptions

Under the NMFS cap, hatchery releases are to be below 197 million smolts per year. "The total hatchery production in 1999 is projected to range from 140 to 150 million smolts, down from the 185 to 195 million range of 1996 to 1998 releases. These reductions are due to ESA concerns, fiscal cutbacks, and the failure of some hatchery programs to receive enough spawning escapement in the last 2 years." (Pollard, 1999). This is, in effect, a 25 percent reduction in hatchery releases. Unless wild fish production increases, a reduction of about 25 percent in economic benefits could be anticipated if this reduction in hatchery release continues. The other expectation may be that decreased hatchery releases increases wild fish survival and that the reduction in hatchery releases increases the number of returning wild spawners, which, in turn, increases overall production.

User Group Allocations

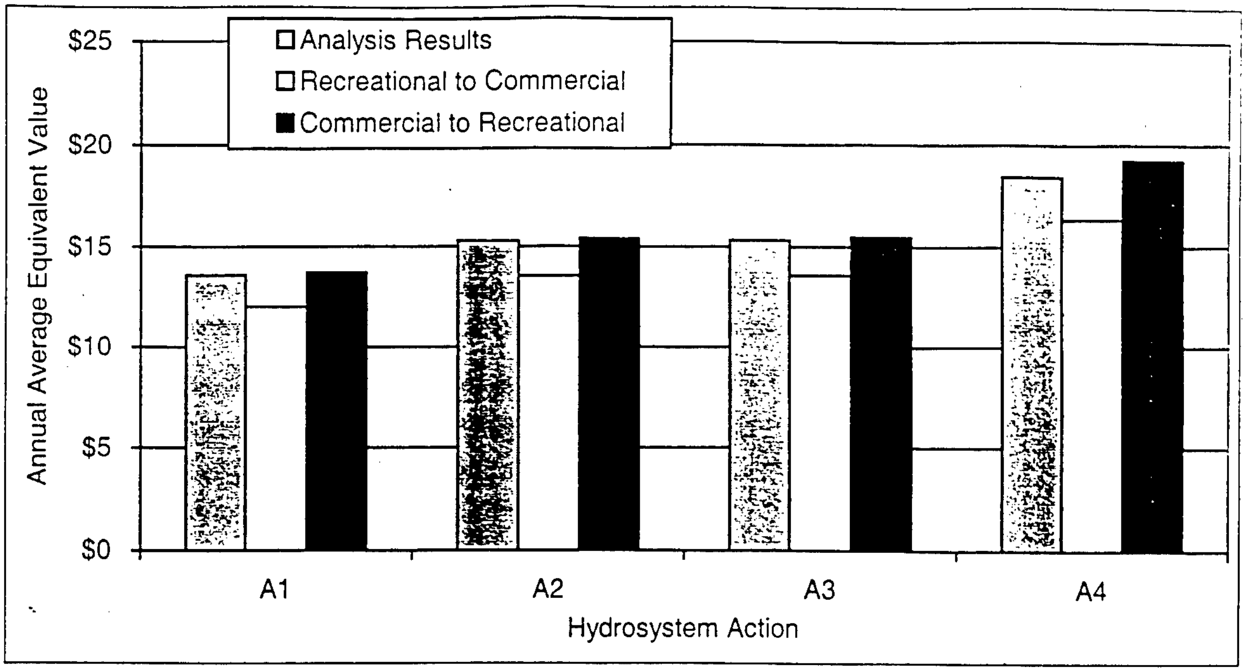
The situation for shifting Snake River production between user groups is complicated because of the overriding influence of summer steelhead contributions to fisheries. There is very little non-treaty commercial use for steelhead. Spring/summer chinook do not have a significant ocean commercial fishery and have not had a viable river gillnet fishery since the late 1980s. Therefore, converting all species from recreational to commercial fisheries would have little effect on increasing economic values from commercial fisheries (Table 3.5-10 and Figure 3.5-9).

Table 3.5-10. Annualized Economic Value (NED Benefits) for Alternative Hydrosystem Actions with Different User Group Allocations (1998 dollars) ($1,000)

	Hydrosystem Action			
Category/Alternative	**1 ($)**	**2 ($)**	**3 ($)**	**4 ($)**
Analysis Results				
AAEV	13.59	15.27	15.33	18.46
Convert Recreational to Commercial				
AAEV	12.02	13.54	13.60	16.34
Difference from analysis results	(1.58)	(1.73)	(1.72)	(2.12)
Convert Commercial to Recreational				
AAEV	13.73	15.41	15.49	19.24
Difference from analysis results	0.14	0.15	0.16	0.78

Note: NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.

AAEV = Average Annual Equivalent Values



Note: NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars.

Source: Study.

Figure 3.5-9. Annualized Economic Value (NED Benefits) for Alternative Hydrosystem Actions with Different User Group Allocations

3.5.5.4 PATH Result Scenarios

The PATH process developed a large set of simulations based on different harvest management, smolt-to-adult survival rates, and other modeling factors. The combinations of assumptions were categorized under several scenario titles, including "equal weights" and "experts." The latter refers to a panel of four experts (called the Science Review Panel, or SRP), which provided weights to seven different hypotheses about life-cycle modeling factors (Marmorek and Peters, 1998). Each of the four simulations that resulted from the weighting was averaged to be the mean-of-expert results. The PATH result scenario for mean-of-expert only applies to spring and summer chinook. NMFS suggests using the newer data and standard statistical methods instead of the expert panel approach (NMFS, 1999).

The simulations made to satisfy the weighting schemes by the SRP were anticipated, because the research would be used to validate or reject the PATH process. While the mean-of-expert scenario is not used in the analysis, the scenario can be useful for showing the range that occurs when using a different base to calculate the economic consequences. Table 3.5-11 shows the average annual NED benefits for the fall chinook, base-case scenario and the spring- and summer-chinook, mean-of-experts scenario. The equal-weights scenario results have slightly higher changed net average annual NED benefits for all of the proposed alternatives. Using the mean-of-experts scenario does not change the order of the alternatives. NED benefits would be larger for Alternative 4, Dam Breaching, under both scenarios.

Table 3.5-11. Changed Annualized Economic Value (NED Benefits) between Base Case and Other Hydrosystem Actions Using Different PATH Scenarios

	Discount Rates					
	0%		4 6/8%		6 7/8%	
Alternative	Amount ($)	Order	Amount ($)	Order	Amount ($)	Order
AAEV Equal Weights						
2	0.97	2	1.56	3	1.67	3
3	0.86	3	1.59	2	1.73	2
4	8.65	1	5.81	1	4.87	1
AAEV Mean of Experts						
2	-0.64	3	-0.35	3	-02.6	3
3	-0.04	2	0.40	2	0.51	2
4	8.36	1	5.35	1	4.35	1
Difference						
2	1.61		1.92		1.93	
3	0.90		1.19		1.22	
4	0.30		0.46		0.51	

1/ NED benefits measured by annual average equivalent value over a 100-year project life in millions of 1998 dollars. Alternatives 2 through 4 are presented net of the base case (Alternative 1, Existing Conditions).

2/ Negative values mean the base case (Action A1) benefits are greater than the hydrosystem actions being compared.

AAEV = Average Annual Equivalent Values.

3.5.6 Unresolved Issues

Several data, model development, and research coordination issues remained to be resolved completion of this analysis. These issues include the following:

- PATH result. The PATH results used in this analysis were based on the most recent available data at the time. PATH is continuing to investigate the effects of hydrosystem actions, and new PATH results are forthcoming. The new results will reflect improved modeling assumptions and methods.
- Fish forecast modeling procedures used to expand PATH results. PATH information for calculated SAR and Year zero may be available in future PATH result releases. This information will preclude some study modeling assumptions used in this analysis for these factors. Some analysts have commented that the assumptions for starting SARs and Year zero abundances using the most recent 10-year period for which complete information is available (1986 to 1995) are too high. Other analysts commented that, with a 100-year forecast horizon, a longer period base average is required.
- PATH result scenarios. This analysis and the recreation and tourism analysis used the PATH spring and summer chinook scenario results called "equal-weights." The analysis for tribal circumstances used the PATH spring- and summer-chinook scenario results called "mean-of-

experts." Some analysts argue that PATH results based on the expert opinions about key PATH model assumptions reflect better science and should be used by all researchers. NMFS (1999) recommends that the expert opinion PATH results be disregarded.

- Economic methods used to evaluate fisheries. For estimating net economic value for commercial harvests, this analysis relies on an accepted approach used by other agencies. The PFMC and others use a percentage of the ex-vessel value as a proxy. Analysts disagree on the appropriate size of this percentage. If the number of additional fish that can be harvested is small, then they could be harvested with no additional effort by fishermen or increase in capacity of the commercial fishery fleet. In this situation, then, 100 percent of the ex-vessel value represents the net economic value. However, if the additional amount of fish made available by the project causes fishermen to use more fuel, labor, or other factors of production, then some lower percentage of ex-vessel value should be used as a proxy for net economic value. This analysis assumes a 70 percent ex-vessel value as a proxy to account for contribution from the harvest sector, the processing sector, and other affected businesses. However, some analysts argue that the percentage should be higher to account for the use of labor from tribal areas, for example, where there are high levels of unemployment, because the opportunity cost of such labor is zero. In such instances, relationships would have to be made specific to each fishery (troll, gillnet, non-tribal, and tribal).

- Coordination with the recreation and tourism analysis. The analysis for general recreation and tourism used different data and methods. The results may not be directly transferable for comparison or roll-up to results presented in this analysis. In particular, the recreational and tourism analysis assumptions concerning angler trip length, trip expenditures, success rates, and angler day benefits are different. The general recreation and tourism analysis also assumes success rates are steady-state (do not vary with increasing run sizes) and that survey results applicable to the lower Snake River area apply to mainstem Columbia River recreational fishing. Better alignment of the anadromous fish analysis and general recreation and tourism analysis could be achieved with adjustments to the angler motivation and choice modeling variables, geographic study areas, and data used for model specification.

- Future fisheries management regimes. This analysis is based on current management regimes in determining harvest levels, fishery effects, and allocations among user groups. Several treaties, court decisions, and other governance understandings are being considered for changes. For example, the PST is currently being negotiated. It is expected that this treaty will soon be adopted, and accordingly, that the results of the PST should be incorporated into this analysis.

- Treaty harvest. The harvest forecast distributional assumptions used by this analysis for ocean and in-river treaty commercial fisheries include ceremonial and subsistence (C&S) harvests. There is concern that double counting may result if C&S harvests are itemized in separate tables in other analyses.

Unresolved issues when related research is being undertaken by separate researchers is not uncommon. Based on further discussion among researchers and comments from the public, appropriate analytical revisions may need to be completed to make results consistent across all study elements.

3.6 Tribal Circumstances (NED)

There are 14 Native American tribes and bands in the region that could be potentially affected by the actions taken to improve fish passage and survival along the lower Snake River. These are the:

- Confederated Tribes of the Colville Indian Reservation
- Confederated Tribes of the Umatilla Indian Reservation
- Confederated Tribes and Bands of the Yakama Nation
- Nez Perce Tribe
- Wanapum Band
- Burns Paiute Tribe
- Coeur d'Alene Tribe
- Confederated Tribes of the Warm Springs Reservation of Oregon
- Kalispel Indian Community of the Kalispel Reservation
- Kootenai Tribe of Idaho
- Northwestern Band of the Shoshoni Nation
- Shoshone-Bannock Tribes of the Fort Hall Reservation
- Shoshone-Paiute Tribes of the Duck Valley Reservation
- The Spokane Tribe of the Spokane Reservation.

Five of these tribes — the Nez Perce Tribe, the Confederated Tribes of the Umatilla Reservation, the Yakama Indian Nation, the Confederated Tribes of the Warm Springs Reservation of Oregon, and the Shoshone-Bannock Tribes — were selected for specific input because of their close cultural and economic links to the salmon. Impacts to tribal circumstances may be viewed in terms of tribal ceremonial, subsistence, and commercial harvest of salmon and tribal access to lands valuable to the tribes. A Tribal Circumstances and Perspectives report was prepared by a private consultant in association with the Columbia River Inter-Tribal Fisheries Commission (CRITFC). According to this report, the ancestors of these five tribes historically valued the salmon first for cultural and spiritual purposes — and secondly to feed their people. The salmon were abundant – and they were also traded and exchanged for other valued goods, both within each tribe, and with peoples from other tribes.

As the salmon have declined, the "surpluses" available to the tribes for trading and commercial sale — after ceremonial and subsistence needs are met — have declined toward zero. The Tribal Circumstances and Perspectives report notes that even ceremonial needs are not met for most of the study tribes. The Shoshone-Bannock bands, who live furthest upriver of the five study tribes, have an absolute prohibition against the commercial sale of salmon. The Nez Perce Tribe, whose reservation lies more immediately above the four lower Snake River dams, has a policy of only selling salmon commercially after ceremonial and subsistence needs are met. In recent years, this has meant little or no sale of salmon harvested above the dams. The peoples of the Yakama, Nez Perce, Umatilla, and Warm Springs reservations all fish in Zone 6 on the mid-Columbia River. Tribal harvest in this zone supports a minimal level of commercial sales activity. Current harvests are identified for the five study tribes in Table 4-2.

Both historically and today, the study tribes emphasize that while revenue obtained from commercial sales of salmon provides important income to tribal peoples, it does not represent the greatest part of value that tribal peoples associate with salmon. For example:

> Salmon is very important to our Indian lives. I have trouble with thinking of salmon only as dollars. You can't drink dollars. You can't eat dollars. Salmon is important to our spiritual life. It helps our spirit survive.
>
> (Terry Courtney, Jr., Warm Springs Fish Commissioner)

Dollar revenue is considered by the tribes to be a severely limited indicator of tribal value and can provide distorted impressions of the full impact on tribes. As a result, the Tribal Circumstances and Perspectives report provides a qualitative assessment of the alternatives considered as part of this FR/EIS. The key findings of this qualitative assessment are summarized in Section 5 of this appendix. A much lengthier discussion is provided in the Tribal Circumstances and Perspectives report (Meyer Resources, 1999a). From the perspective of the WRC guidelines that inform the overall economic analysis conducted as part of this FR/EIS (see Section 1.3), the discussion presented in Section 5 is part of the environmental quality account, which addresses non-monetary effects on significant natural and cultural resources.

While it is not possible to assign dollar values to Tribal ceremonial and subsistence harvest or to the relationship between salmon and tribal culture, spirituality, material well-being, and health, dollar values are assigned to tribal commercial fish harvest as part of the NED economic analysis conducted by the Drawdown Regional Economic Workgroup (DREW) Anadromous Fish Workgroup. This analysis, summarized in Section 3.5, estimates the future value of Tribal commercial harvest as a percentage of the total run sizes projected under each alternative. These projections are based on preliminary PATH data extended by the DREW Anadromous Fish Workgroup to represent all Snake River wild and hatchery stocks. The National Marine Fisheries Service (NMFS) analysis uses more recent PATH data.

There are four outstanding issues associated with the tribal portion of the DREW Anadromous Fish Workgroup's analysis. First, the Anadromous Fish Workgroup's analysis assigns commercial harvest value to the majority of the projected tribal harvest. A small fraction of the projected runs are excluded from the commercial analysis but it is likely that tribal ceremonial and subsistence harvests comprise a larger share than assumed by the Anadromous Fish Workgroup's analysis. Assigning percentages of tribal harvest to different types of use — commercial, ceremonial, or subsistence — is complicated because the boundaries between these types of use are not always clearly defined. This could theoretically result in "double-counting" of ceremonial and subsistence harvest, which are also addressed qualitatively in Section 5.0. A second concern, raised on behalf of the tribes (Meyer Resources, 1999b), is that dollar values assigned to tribal commercial harvests by the Anadromous Fish Workgroup's analysis are not high enough. Third, the Tribal Circumstances and Perspectives report suggests that the projected fish runs may be overestimates because the PATH analysis is built from present-day conditions and fails to incorporate long-term negative trends in Columbia River/Snake River stock sizes. The report also suggests that the year zero assumptions, which were developed by the DREW Anadromous Fish Workgroup, likely exceed PATH's present conditions by approximately 34 percent for spring/summer chinook, and 43 percent for fall chinook (Meyer Resources, 1999a; 214). Finally, it should be noted that the DREW Anadromous Fish Workgroup's analysis is based on unweighted PATH data. The tribes prefer to use the PATH data that was weighted by the PATH Scientific Review Panel and consider the use of the unweighted numbers to be a "retreat from best science" (Meyer Resources, 1999a; 214). Due to concerns associated with the weighting process, unweighted PATH results were used in all other analyses for this feasibility study.

3.7 Flood Control

The following is a qualitative evaluation of the flood control impacts of the four dams in the lower Snake River project. A quantitative flood control analysis has been omitted from the Feasibility Study because flood control benefits are not currently provided by the lower Snake River dams. Flood control benefits would also not be provided under a dam breaching alternative. A flood control benefit is a reduction in river stage or flow due to project operations. This section describes current, and predicts future, flood conditions, and demonstrates that flooding after removing the earthen portions of the four lower Snake River dams would be no worse than under current operations or conditions.

3.7.1 Current Flood Control

The four lower Snake River dams (Ice Harbor, Lower Monumental, Little Goose, and Lower Granite) were authorized for power, recreation, irrigation, transportation and fish and wildlife. They are not authorized by Congress for flood control. The four dams that make up the lower Snake River project were designed to operate as run-of-the-river facilities within small pool fluctuation ranges. The maximum and minimum authorized pool operating limit elevations for the four dams are measured at the project forebay gage of each dam, except for Lower Granite, which is measured at the gage located at the confluence of the Snake River and Clearwater River at Lewiston, Idaho. The authorized operating pool elevations and corresponding storage contents for that elevation range are summarized in Table 3.7-1.

The total storage capability contained within the operating range for the four projects is 137,400 acre-feet when inflows are low and the pool elevations are nearly flat between the forebay gage and the upstream end of the project. The pool elevations refer to the water surface elevation at the project forebay, except for Lower Granite. Its pool elevation refers to the Snake-Clearwater confluence gage. The Biological Opinion specifies that the pool elevations be restricted to the one foot range above MOP; therefore, the total usable storage is approximately 33,500 acre-feet.

Table 3.7-1. Authorized Operating Pool Elevations and Storage Contents

Project	Minimum Pool (feet)	Maximum Pool (feet)	Range (feet)	Storage (acre-feet)
Lower Granite	733.0	738.0	5.0	43,600
Little Goose	633.0	638.0	5.0	48,900
Lower Monumental	537.0	540.0	3.0	20,000
Ice Harbor	437.0	440.0	3.0	24,900

This amount of usable storage is too small to make any measurable reduction in the flood flows of the Columbia River. Dworshak's storage capability is 2,000,000 acre-feet, which is approximately 15 times greater than the total storage capability of the lower Snake River projects and approximately 60 times greater than the total usable storage.

These projects have not been used for flood control on the Columbia River in the past; however, the potential to use storage space that would become available during a partial lower Snake River drawdown operation was evaluated during the Columbia River SOR. All four lower Snake River dams must be drawn down for a flood control benefit to be realized at The Dalles (BPA, 1995). The

drawdown referred to in the SOR was part of the partial drawdown system operation strategy (SOS 6b). The proposed partial drawdown elevations for SOS 6b were below authorized operating limits, but still high above natural river levels at the project forebays.

The lower Snake River dams were not designed and are not operated to provide flood control benefits because flood control is not a congressionally authorized project use. According to the 1995 Columbia River System Operation Review (SOR) EIS (BPA, 1995), the projects are physically capable of providing a minor benefit under a partial drawdown operation strategy, but only when coupled with major reconstruction of the projects. The reconstruction would be necessary to continue current congressionally authorized uses and operation of fish passage facilities. The Dworshak project located upstream on the Clearwater River currently provides congressionally authorized flood control benefits for the lower Snake River and further downstream on the Columbia River.

Before the project storage below the authorized operating limits (for a non-dam breaching alternative) could be used for flood control, each project's facilities would have to be rebuilt. This would include the spillways, powerhouse intakes and outlets, navigation facilities, fish facilities, and reservoir embankments. For example, the 1992 Lower Granite drawdown test demonstrated that the turbines would be damaged by excessive vibration and the transportation facilities would be damaged by slumping reservoir embankments.

A dam breaching alternative, which would involve removal of the earthen portions of each of the four dams, would not provide a flood benefit because there would be no reservoirs on the lower Snake River to store flood waters. There would be no physical capability to control flooding on the lower Snake River, except by Dworshak Dam, on the Clearwater River. The current Biological Opinion specifies that the lower Snake River pools elevations are to remain within one foot of the minimum operating pool (MOP) elevation. This precludes the current projects from storing flood waters, which makes the current flood control capability the same as it would be under a dam breaching alternative.

3.7.2 Future Flood Control

Future flood stages without the four lower Snake River dams in place would be no worse (higher) than the current flood stages. Removing the earthen portions of the dams would lower future water surface elevations down to natural river levels from the current pool elevations. This reduction would be greatest at the project forebays and least at the project tailwaters; therefore, local flood control benefits would be provided, particularly at the project forebays. This benefit would not be provided downstream of Ice Harbor Dam. Removing the earthen portions of the dams would eliminate the potential to operate the project for flood control; however, this potential was never authorized and would be cost prohibitive due to the major project reconstruction that would be required to maintain authorized uses. Dworshak will continue to provide flood control benefits in the lower Snake River and downstream on the Columbia River.

The upstream extent of flood control effects due to removing the earthen portion of the dams would reach the Lewiston area. Lower Granite Dam creates a backwater upstream to Lewiston. Levees were constructed in this area to provide navigation and power generation benefits. They were not constructed to provide flood control benefits. No future water surface reduction would result from removal of the earthen portion of Lower Granite Dam, and no subsequent flood control benefit would be provided, upstream of the backwater currently created by the project.

Under Alternative 4, Dam Breaching, the tailwater elevation downstream of Ice Harbor Dam would be approximately the same as under current conditions. The upstream extent of backwater in the lower Snake River, due to McNary Dam on the Columbia River, typically does not reach Ice Harbor Dam. Public comments during outreach meetings with the Corps have included claims of flooding in the Burbank area prior to dam construction. Current flood control benefits near Burbank are provided by Dworshak, which will continue to the provide flood control benefits to the Burbank area in the future.

These flood control benefits are not expected to be reduced if the earthen portions of the dams are removed, unless the channel and floodplain are filled in by subsequent sediment deposition. These sediments would be scoured from the reservoir beds and banks of the four lower Snake River dams, during and after removal, and transported downstream. There is not enough information available to quantitatively evaluate, and accurately predict, flood control impacts due to deposition of sediments near the Columbia-Snake confluence (Reese, 1998). The Corps is proposing to monitor and measure sediment deposition near this confluence to mitigate for this potential impact.

Another potential change in future flood control benefits would result from changes in the operation of Dworshak. The issue lies in the amount of water released from Dworshak Reservoir for the purpose of flow augmentation in the lower Snake River. Flow augmentation reduces the potential for excessive low flows in the lower Snake River, as well as enhancing fish habitat by increasing water velocity and reducing water temperature. Currently, the details of the amount of flow augmentation included in the future alternatives, the subsequent changes in Dworshak operations, and the resulting impact on flood control are not known.

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3.8 Implementation/Avoided Costs

3.8.1 Introduction and Study Organization

The purpose of this section of the analysis is to describe and display the *equivalent average annual costs* associated with implementation and avoided costs for each of the study alternatives under consideration. These costs are presented as equivalent average annual costs. The following discussion is divided into six sections: discussion of alternatives, implementation costs, average annual costs, avoided costs, risk and uncertainty, and other considerations.

3.8.2 Discussion of Alternatives

The construction and acquisition costs associated with each of the four alternatives are presented in Table 3.8-1. These costs are:

- based on the detailed project schedule PB-2A and Appendix D and E engineering annexes (Annexes A through D)
- at the concept level, based on a 100-year life cycle analysis
- developed at a price level October 1, 1998 (e.g., the start of the fiscal year) and adjusted to the year 2005 which is the starting year of construction.

Table 3.8-1. Total Construction & Acquisition Costs by Study Alternative (1998 dollars) ($1,000)[1/]

Alternative	Detailed Description	Starting Year	Construction & Acquisition Costs ($)
1 - Existing Conditions	Adaptive Management Strategy	2005	97,990
2 - Maximum Transport of Juvenile Salmon	Maximum Transport	2005	74,693
3 - Major System Improvements	SBC with Maximum Transport (low cost)	2006	167,972
4 - Dam Breaching	Channel Bypass or Natural River Alternative	2007	809,530

1/ These costs have been adjusted to base year 2005 using the 6.875 percent discount rate.
SBC—Surface Bypass Collectors
Source: U.S. Army Corps of Engineers, Walla Walla District

The starting dates of the various alternatives, indicating when each project will be functional, range from 2005 to 2010. However, it should be noted that this schedule is based on the following assumptions:

- that a record of decision will be made with work commencing in FY 2001
- that funding and other limitations will not impact the implementation schedule.

Failure to reach a record of decision or delays for any other reason will delay the starting date of the projects.

3.8.2.1 Comparison of Annual Implementation & Avoided Costs

Annual implementation and avoided costs are presented for the four alternatives in Figure 3.8-1. The annual costs for the dam breaching alternative are higher than those for the other alternatives from 2001 through 2009 because annual construction costs to breach the dams are significantly larger than the construction costs associated with improving the existing system. Construction costs are, however, completed for all alternatives by the year 2009. From 2010 until the end of the study period (2104) the on-going annual implementation and avoided costs are lower under the dam breaching alternative than under the other three alternatives.

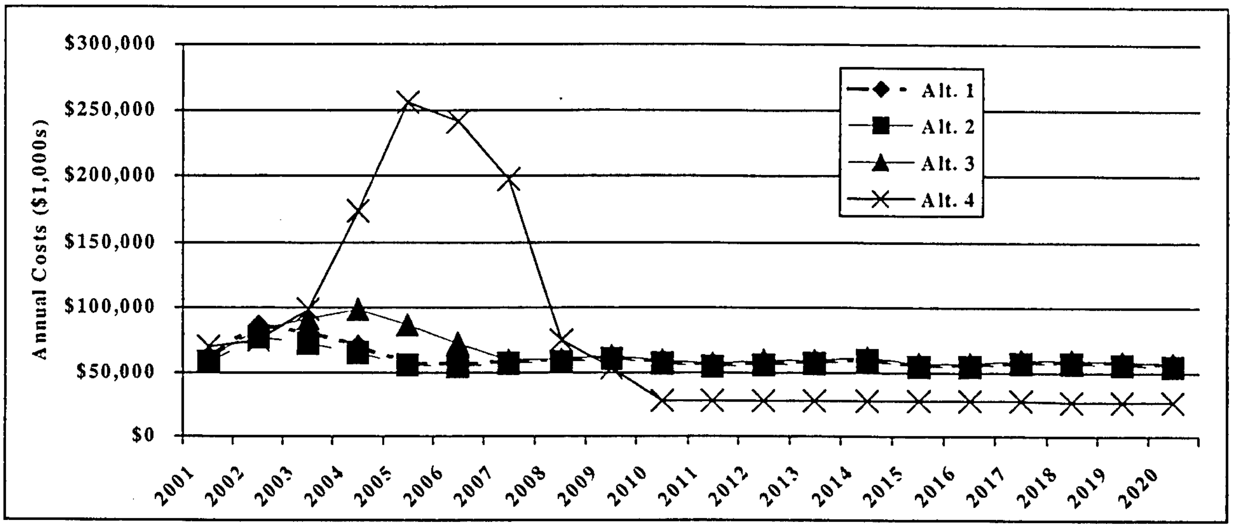

Figure 3.8-1. Comparison of Annual Implementation & Avoided Costs

3.8.3 Implementation Costs

Implementation costs considered in the following discussion include all project-related construction and acquisition costs and operation, maintenance, repair, replacement and rehabilitation costs (O,M,R,R&R) associated with construction and operation activities required under each alternative. Implementation costs also include mitigation costs for fish and wildlife programs, cultural resources, and tribal responsibilities. Mitigation costs are discussed in more detail in Section 12, Compensatory Actions.

Construction and acquisition costs are presented by major cost category for each alternative in Table 3.8.2.

3.8.3.1 Construction and Acquisition Costs for Dam Retention Alternatives

Improvements designed to enhance the performance of existing fish facilities are planned for Alternative 1, Existing Conditions, Alternative 2, Maximum Transport, and Alternative 3, Major System Improvements. Improvements proposed to reduce fish fatality at the turbines at each of the four dams include cam field test improvement studies and related cam improvements on the turbines. Each of the dams has six turbines, which would be sequentially improved. The cost to study and enhance the cams is estimated to be $3.5 million, as shown in Table 3.8-2. In addition, there are a series of fish-related improvements planned for each dam including:

Table 3.8-2. Total Construction & Acquisition Costs Adjusted to Base Year 2005 (1998 dollars) ($1,000)*

Cost Category by Alternative	1	2	3	4
Improvements to Existing Fish Facilities				
Gantry Crane Modifications	630	630	630	---
Fish Facility Cylindrical Dewatering System	1,433	1,430	1,430	---
ESBS Modifications	1,780	1,780	1,780	---
Cam Improvements and Studies	3,546	3,546	3,546	---
Trash Boom	5,280	5,280	5,280	---
Separator Improvements	7,262	7,260	7,260	---
Additional Barges & Moorage Cells	9,270	9,270	9,270	---
Aux. Water Supply Fish Ladder	10,805	10,805	10,805	---
Degasification Efforts	33,676	10,384	10,384	---
Juvenile Fish Facility Improvements	24,308	24,308	24,308	---
Sub-total	98,000	74,693	74,693	---
Additional New Fish Facility Improvements				
Prototypes, Testing of surface bypass collectors (SBC)	---	---	1,024	---
New Extended Screen Bypass (ESB) Screens	---	---	32,718	---
Full Flow Bypass SBC w/ Modified Spillbay	---	---	59,537	---
Sub-total	---	---	93,279	---
Dam Breaching Construction Costs				
Real Estate (Excessing Property)	---	---	---	841
Project Dam Decommissioning	---	---	---	5,006
Cultural Resources Protection	---	---	---	5,999
Cattle Watering Facilities	---	---	---	6,030
Drainage Structures Protection	---	---	---	8,830
Lyons Ferry Hatchery Modifications	---	---	---	9,047
HMU Modification	---	---	---	8,841
Recreation Access Modification	---	---	---	12,509
Railroad Relocations	---	---	---	21,913
Power House Turbine Modifications	---	---	---	30,952
Reservoir Revegetation (For Air & Water Quality)	---	---	---	26,336
Temporary Fish Handling Facilities	---	---	---	37,018
Bridge Pier & Abutment Protection	---	---	---	48,321
Railroad and Roadway Damage Repair	---	---	---	95,538
River Channelization	---	---	---	123,446
Dam Embankment Removal	---	---	---	158,775
Reservoir Embankment Protection	---	---	---	184,432
Sub-total	---	---	---	783,834
Mitigation Costs	---	---	---	25,696
Total	97,990	74,693	167,972	809,530

* These costs have been adjusted to base year 2005 using the 6.875 percent discount rate.
Source: U.S. Army Corps of Engineers, Walla Walla District

- Auxiliary water supplies for fish ladders—these improvements at each of the four lower Snake River projects would result in a total cost of $10.8 million across all four projects.
- Fish facility cylindrical de-water systems, which are needed at Ice Harbor, Lower Monumental and Little Goose but not at Lower Granite, are expected to cost $460,000 per affected project or $1.4 million for all three affected projects.
- Gantry crane modifications are needed at Lower Monumental, at a cost of $630,000.
- Juvenile fish facility improvements, which are needed at Lower Granite, are expected to cost $24.3 million.
- Separator improvements, which are needed at Lower Monumental and Little Goose, are expected to cost approximately $7.3 million in total.
- De-gasification improvements (DGAS) at Lower Monumental, Little Goose and Lower Granite, have already been implemented at Ice Harbor. These improvements, which include adding end bay deflectors and modifying the deflectors and pier extensions, are planned to decrease gasification and improve water quality. Under the base case, the cost of these improvements is $33.7 million across all projects.
- Improvement to the Trash boom (used to pickup trash and debris at the project) at Little Goose dam, at a cost of $5.3 million.
- Additional barges and improved barge moorage cells at Lower Granite, which are intended to improve and enhance the fish transportation program, are expected to cost $9.3 million (e.g., $6.7 million for five additional barges and $2.6 million for an improved barge moorage cell).
- Extended screen bypass systems (ESBS) are expected to cost $1.8 million.

Additional Fish Facility Improvements (Alternative 3, Major System Improvements)

Additional major systems improvements are planned under Alternative 3. These include conducting studies and installing extended screen bypass collection systems (ESBS) at the Ice Harbor, Lower Monumental, and Lower Granite dams. These improvements are estimated to cost $93.3 million.

3.8.3.2 Construction and Acquisition Costs for Alternative 4, Dam Breaching

The implementation costs associated with Alternative 4, Dam Breaching, are summarized in this section. The construction costs associated with this alternative are also summarized in Table 3.8-2. The construction process includes modifying, removing, or protecting structures (e.g., roads, railroads, bridges, reservoir embankments, drainage structures, recreation access corridors, the hatchery at Lyons Ferry and like structures) that would remain after the dams are breached. The largest construction costs are for dam embankment removal and river channelization, which in combination, exceed $70 million at each of the dams. Each dam embankment is scheduled for removal concurrently over a three-year period between 2004 and 2007. There would be a need to shore up the reservoir embankment prior to water release to prevent the undermining of the riprap and structures along the banks once the river is returned to a natural state. There would also be a

need to re-vegetate the newly exposed banks of the river. In addition, before the dams are breached, temporary fish handling facilities would be needed.

The power house turbine modifications identified in Table 3.8-2 would allow a controlled release of the water in the reservoirs behind the dams and are not the same as the turbine rehabilitation projects under dam retention strategies. Also planned is modification of cattle watering corridors,[11] modification of habitat management units (HMUs), and protection of cultural resources after dam breaching and river channelization.

Mitigation Costs (Alternative 4, Dam Breaching)

The mitigation costs under Alternative 4, Dam Breaching, include those associated with fish and wildlife habitat mitigation efforts and cultural resources preservation associated with preserving and protecting habitat and cultural sites such as burial grounds.

3.8.3.3 O, M, R, R&R Costs for Dam Retention Alternatives

In addition to construction costs, O,M,R,R&R costs would also occur with implementation of the project-related or fish-improvement components of Alternatives 1 through 3. Some of the costs are associated with studies and others are related to operation and maintenance of the fish-improvement systems. The efforts to maintain and enhance existing fish-related facilities and operations are summarized in Table 3.8-3 and include:

- Continued study of anadromous fish (called the anadromous fish evaluation program or AFEP) involves a process for testing, research and evaluating how well the proposed improvements meet fish-improvement goals and objectives. The AFEP study costs occur for approximately 25 years during construction and rehabilitation improvements. Total AFEP costs adjusted to base year 2005 are expected to range from a low of $55 million under Alternative 2, Maximum Transport of Juvenile Salmon, to a high of $88 million under Alternative 3, Major System Improvements.
- BOR water acquisition costs allow an increased volume of water to pass over the dams during critical flow periods. The water is purchased from natural (irrigator) flow rights, changes in Snake River reservoir operations, and additional water from BOR storage reservoirs. Water purchases are expected to continue to occur throughout the study period to meet flow requirements, at an estimated total cost of $43 million over the 100-year study period adjusted to base year 2005 for the existing flow augmentation requirement of 427,000 acre feet (AF) of water.
- Total maintenance costs associated with screen bypass collector systems for Alternative 3, Major System Improvements, are expected to cost $10 million over the 100-year life of the project adjusted to base year 2005.

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[11] It should also be noted here that cattle watering corridor modification costs were included in the implementation costs because of deed requirements. Refer to the Engineering Appendix for further details regarding what constitutes implementation costs.

Table 3.8-3. Total Project-Related O, M, R, R&R Costs (1998 dollars) ($1,000)*

Cost Category by Alternative	Alternative 1 ($)	Alternative 2 ($)	Alternative 3 ($)	Alternative 4 ($)
Anadromous Fish Evaluation Program	82,413	55,488	88,516	38,428
BOR Water Purchase	43,300	43,300	43,300	43,300
Wildlife Monitoring	---	---	---	179
Vegetation Monitoring	---	---	---	382
Fish Monitoring Costs	---	---	---	32,442
Water Quantity Monitoring Costs	---	---	---	6,094
Air Quality Monitoring Costs	---	---	---	504
Sedimentation Monitoring Costs	---	---	---	1,553
Fish Improvement Related, Dam Operation, Maintenance and Repair	---	---	10,068	---
Total	125,713	98,788	141,884	122,882

* Costs are adjusted to base year 2005 using the 6.875 percent discount rate.
Source: U.S. Army Corps of Engineers, Walla Walla District

3.8.3.4 O, M, R, R&R Cost for Alternative 4, Dam Breaching

In addition to the mitigation and construction/acquisition costs, there are ongoing operation and maintenance (O&M) costs associated with the continued anadromous fish evaluation program, the purchase of water by the BoR, and the monitoring costs associated with dam breaching. These costs are also summarized in Table 3.8-3. Total AFEP costs for the 100-year period of study are estimated to be $38 million and monitoring costs are estimated to equal $41,160, as adjusted to the base year 2005.

3.8.4 Average Annual Costs

3.8.4.1 Average Annual Costs of Fish Facility Improvements

This section presents a summary of the total and average annual implementation costs. Construction, IDC, AFEP and O,M,R,R&R costs are displayed in average annual equivalent terms taking into account the 100-year period of analysis and adjusted to base year 2005 in Table 3.8-4.

Costs incurred during the period of analysis were discounted to the beginning of this period using the applicable discount rates. Implementation costs incurred during the period of installation (following October 2000) were brought forward to the end of the installation period by charging compound interest at the applicable discount rate from the date that the costs were incurred. These costs were then converted into 1998 dollars and annualized to provide an average annual value for each alternative. This analysis presents average annual costs using three discount rates: the Corps' rate of 6.875 percent, the BPA rate of 4.75 percent, and 0.0 percent at the request of the five Tribes represented by CRITFC.

Table 3.8-4. Summary of Implementation Costs (1998 dollars) ($1,000s)

Discount Rate by Alternative	Construction and Acquisition Cost ($)	Interest During Construction Cost ($)	Total Investment Cost ($)	Average Annual Investment Cost ($)	Average Annual AFEP Cost ($)	Average Annual O,M,R,R&R Cost ($)	Average Annual Implementation Cost ($)
@ 6.875 Percent							
Alternative 1	89,258	8,732	97,990	6,745	5,673	2,984	15,402
Alternative 2	67,904	6,789	74,693	5,141	3,820	2,984	11,945
Alternative 3	151,939	16,033	167,972	11,563	6,093	3,677	21,333
Alternative 4	759,093	50,437	809,530	55,727	2,645	5,817	64,189
@ 4.75 Percent							
Alternative 1	89,258	5,971	95,229	4,567	4,498	2,759	11,824
Alternative 2	67,904	4,641	72,545	3,480	3,029	2,759	9,268
Alternative 3	155,021	11,131	166,152	7,969	4,831	3,400	16,200
Alternative 4	800,224	35,688	835,912	40,092	2,097	5,133	47,322
@ 0.0 Percent							
Alternative 1	89,258	0	89,258	893	1,373	2,423	4,689
Alternative 2	67,904	0	67,904	679	924	2,423	4,026
Alternative 3	162,384	0	162,384	1,624	1,474	2,981	6,079
Alternative 4	911,122	0	911,122	9,111	640	3,236	12,987

Source: U.S. Army Corps of Engineers (Walla Walla District, Portland District), BPA and BST Associates

The major cost categories include:

- Construction costs for fish-improvement projects and/or to breach the dams. Construction costs associated with the Alternative 4, Dam Breaching include mitigation costs, such as wildlife mitigation and cultural resources protection.
- Interest during construction (IDC), which reflects compound interest, at the applicable borrowing rate, on construction costs incurred during the period of installation,
- Anadromous fish evaluation program (AFEP), and,
- O,M,R,R&R costs associated with the new fish improvement projects (e.g., purchase of water from BOR and the O&M costs associated with the screen bypass system proposed under Alternative 3, Major System Improvements).

Average annual costs vary widely depending upon which discount rate is used but the ranking of the alternatives remains constant. Alternative 2, Maximum Transport of Juvenile Salmon, is the lowest cost alternative (in fact, it has a lower cost than the base case). Alternative 1, Existing Conditions and Alternative 3, Major System Improvements, are the next lowest cost alternatives, while Alternative 4, Dam Breaching, is the highest cost alternative, under all discount rates.

3.8.5 Avoided Costs

The avoided costs associated with each alternative include those costs that would no longer be required to operate and maintain the lower Snake River dams and associated lands. These costs are calculated by comparing the continued operation of the four lower Snake River lock and dams under the Base Case conditions (Alternative 1, Existing Conditions) with Alternatives 2 through 4. Costs under Alternative 1 that are not included in the other alternatives are considered avoided costs.

Avoided costs include:

- Avoided costs of construction or major upgrades that would occur with Alternative 1, Existing Conditions, but not under other alternatives. These include major powerhouse system upgrades, and, specific additional major improvements to fish bypass, collection and passage systems.
- Avoided O&M costs incurred under Alternative 1, Existing Conditions, but not under other alternatives. These include future annual O&M costs, and, additional annual repair costs.
- Disposition of equipment that could be surplused, if the dams were breached represents a third type of cost included in this analysis. This represents a reduced opportunity cost for other Federal agencies seeking this type of property and may, therefore, be considered a form of avoided costs.

3.8.5.1 Avoided Construction Costs

The major fish-improvement cost incurred under Alternative 1, Existing Conditions, that does not occur in Alternatives 2, 3, or 4 is the second phase of the de-gasification construction project (DGAS2). This project is required to reduce nitrogen saturation resulting from additional flows. It is not required under Alternatives 2 and 3 because these alternatives involve additional collection efforts above the dams that would reduce the need for additional spills and related system improvements. The additional construction cost associated with the DGAS2 project is approximately $21 million.

There are, however, additional costs associated with Alternatives 2 and 3 that are not required under Alternative 1, Existing Conditions. As a result, net avoided costs for fish-related improvements only occur under Alternative 2, Maximum Transport of Juvenile Salmon. These costs are, however, included in the comparison of implementation costs and would be double-counted if included again as avoided costs.

3.8.5.2 Avoided Non-Project Related OMRR&R Costs

Under Alternative 4, Dam Breaching, the earthen embankment of the four lower Snake River dams would be removed. As a result, the power house rehabilitation costs and the annual O&M non-project related costs associated with the base case (Alternative 1, Existing Conditions) would be significantly reduced. These are included as avoided costs under Alternative 4, Dam Breaching. The avoided costs under the Alternative 4 include:

- Avoided rehabilitation of the power houses at each of the four dams. Currently proposed rehabilitation includes all 24 turbine and generator units (including the turbines, the turbine blades, rewinding generators, and miscellaneous work). Over the study period, this rehabilitation is expected to cost approximately $380 million for the entire system. This effort is

underway at the present time at Ice Harbor Dam, which was built earlier than the other three lower Snake River dams, and will be required again in approximately 50 years. The 24 lower Snake River dam turbine units have an approximate life span of 25 to 50 years. It takes approximately 10 years to rehabilitate the six turbine units at each dam and only one turbine unit can be rehabilitated at a time for several reasons (including the need to continue generating power during the rehabilitation process and funding limitations).

- Avoidance O&M and other minor repair activities are expected to average $25 million per year throughout the life of the system for those alternatives that retain dam operations. Some of the annual O&M costs, such as those associated with maintenance of HMUs and recreation facilities, would also occur under Alternative 4, Dam Breaching. In addition, the annual costs of $14.4 million to operate the Lyons Ferry fish hatchery would occur under all four alternatives (including Alternative 4). Avoided costs under Alternative 4, Dam Breaching, would be partially offset by the normal dam operating expenditures that would occur between 2001 and the actual dam breaching (2007). In addition, after dam breaching, there would be continuing O&M costs associated with the operation and maintenance of the existing HMUs and parks.

- Real property could be disposed of under Alternative 4 once the dams are breached. Personal property that is currently utilized at the lower Snake River projects could be transferred to other Federal agencies and hence represents another avoided cost of dam breaching. The total value of personal property at the lower Snake River lock and dams calculated for those items with a value greater than $2,500 is approximately $14.9 million.

3.8.5.3 Summary of Avoided Costs

The avoided costs associated with Alternative 4, Dam Breaching are approximately $29 million per year over the life of the study, under all discount rates, as shown in Table 3.8-5. Using the 6.875 percent discount rate as an example, the avoided costs are calculated by subtracting the sum of the annual costs for turbine replacement, O,M,R,R,&R costs, and surplus property value under the base case alternative (e.g., $64,783,000) from Alternative 4, Dam Breaching (e.g., $35,605,000) which equals an annual avoided cost of $29,178,000.

Table 3.8-5. Summary of Avoided Costs (1998 dollars) ($1,000s)

Discount Rate/ Alternative	Turbine Rehabilitation ($)	Non-Project Related O,M,R,R&R ($)	Surplus Property ($)	Sub-Total ($)	Avoided Costs ($)
@ 6.875 Percent					
Alternative 1	4,800	58,955	1,028	64,783	---
Alternative 2	4,800	58,955	1,028	64,783	---
Alternative 3	4,800	58,962	1,028	64,790	---
Alternative 3	---	35,605	---	35,605	(29,178)
@ 4.75 Percent					
Alternative 1	4,579	54,476	716	59,771	---
Alternative 2	4,579	54,476	716	59,771	---
Alternative 3	4,579	54,499	716	59,794	---
Alternative 4	---	30,428	---	30,428	(29,343)
@ 0.0 Percent					
Alternative 1	3,871	46,935	149	50,955	---
Alternative 2	3,871	46,935	149	50,955	---
Alternative 3	3,871	47,412	149	51,432	---
Alternative 4	---	21,905	---	21,905	(29,050)

Source: U.S. Army Corps of Engineers (Walla Walla District, Portland District), BPA and BST Associates

3.8.6 Risk & Uncertainty

The following section presents an evaluation of the risk and uncertainty associated with the implementation and avoided cost analysis. The range of uncertainty within each cost estimate is based on the following estimates of contingencies:

- 15 percent to 25 percent contingency range for construction and acquisition costs associated with the dam retention alternatives (with a most likely estimate of 20 percent),
- 25 percent to 35 percent contingency range for construction and acquisition costs associated with the dam breaching alternative (with a most likely estimate of 30 percent),
- 0 percent to 10 percent contingency range for O,M,R,R&R under all alternatives (with a most likely estimate of 5 percent),

3.8.6.1 Risk & Uncertainty in Average Implementation Costs

Based upon these contingencies, the range of costs for fish facility improvements is presented in Table 3.8-6. As shown, total average annual implementation costs (including all construction and other costs) range from $61.0 to $67.4 million under Alternative 4, Dam Breaching, with a most likely cost estimate of $64.2 million per year under a discount rate of 6.875 percent. The annual implementation costs net of the base case range from $46.3 to $51.2 million, with a most likely net cost of $48.8 million.

Table 3.8-6. Implementation Costs—Risk & Uncertainty (1998 dollars) ($1,000s)

Discount Rate/	Annual Implementation Costs ($)			Net of Base Case ($)		
Alternative	Most Likely	Low	High	Most Likely	Low	High
@ 6.875 Percent						
Alternative 1	15,402	14,632	16,172			
Alternative 2	11,945	11,348	12,542	(3,457)	(3,284)	(3,630)
Alternative 3	21,333	20,266	22,400	5,931	5,634	6,228
Alternative 4	64,189	60,980	67,398	48,787	46,348	51,226
@ 4.75 Percent						
Alternative 1	11,824	11,233	12,415			
Alternative 2	9,268	8,805	9,731	(2,556)	(2,428)	(2,684)
Alternative 3	16,200	15,390	17,010	4,376	4,157	4,595
Alternative 4	47,322	44,956	49,688	35,498	33,723	37,273
@ 0.0 Percent						
Alternative 1	4,689	4,455	4,923			
Alternative 2	4,026	3,825	4,227	(663)	(630)	(696)
Alternative 3	6,079	5,775	6,383	1,390	1,321	1,460
Alternative 4	12,987	12,338	13,636	8,298	7,883	8,713

Source: U.S. Army Corps of Engineers (Walla Walla District, Portland District), BPA and BST Associates

Under the same discount rate, the average annual implementation costs for the three dam retention alternatives are estimated to be as follows:

- implementation costs for Alternative 1, Existing Conditions, range from $14.6 to $16.2 million, with a most likely estimate of $15.4 million,
- implementation costs for Alternative 2, Maximum Transport of Juvenile Salmon, range from $11.3 to $12.5 million, with a most likely estimate of $11.9 million (e.g., ranging from a negative $3.3 to negative $3.6 million net of the base case), and,
- implementation costs for Alternative 3, Major System Improvements, range from $20.3 to $22.4 million, with a most likely estimate of $21.3 million (e.g., ranging from $5.6 to $6.2 million net of the base case).

3.8.6.2 Risk & Uncertainty in Average Annual Avoided Costs

Based upon a 5 percent contingency, the range of annual costs for non-project related operations, maintenance, repair, replacement and rehabilitation costs (O, M, R, R and R) are presented in Table 3.8-7. As discussed above, there are a number of on-going annual costs incurred in dam retention alternatives that are avoided under the Alternative 4, Dam Breaching.

Table 3.8-7. Avoided Costs—Risk & Uncertainty (1998 dollars) ($1,000s)

Discount Rate/ Alternative	Annual Non-Project Related Costs ($) Most likely	Low	High	Avoided Costs ($) Most likely	Low	High
@ 6.875 Percent						
Alternative 1	64,783	61,543	68,022			
Alternative 2	64,783	61,543	68,022			
Alternative 3	64,790	61,550	68,029			
Alternative 4	35,605	33,825	37,385	(29,178)	(27,719)	(30,637)
@ 4.75 Percent						
Alternative 1	59,771	56,782	62,760			
Alternative 2	59,771	56,782	62,760			
Alternative 3	59,794	56,804	62,784			
Alternative 4	30,428	28,907	31,949	(29,343)	(27,876)	(30,810)
@ 0.0 Percent						
Alternative 1	50,955	48,408	53,503			
Alternative 2	50,955	48,408	53,503			
Alternative 3	51,432	48,861	54,004			
Alternative 4	21,905	20,810	23,000	(29,050)	(27,598)	(30,503)

Source: U.S. Army Corps of Engineers (Walla Walla District, Portland District), BPA and BST Associates

Avoided costs are calculated by subtracting the annual costs associated with the base case from those associated with the dam breaching alternative. For example, the most likely annual avoided costs are calculated by subtracting the base case average annual costs of $64.8 million from the dam breaching average annual costs of $35.6 million, which equals ($29.2 million) at a discount rate of 6.875 percent. The average annual avoided costs range between $27.7 and $30.6 million, with a most likely cost estimate of $29.2 million per year under a discount rate of 6.875 percent. Table 3.8-7 also presents the annual avoided costs under the 4.75 percent and 0.0 percent discount rates.

3.8.7 Other Considerations

3.8.7.1 Repayment of Outstanding Debt

The Bonneville Power Administration (BPA) repays to the Federal Treasury costs allocated to hydropower from the Federal dams. The capitalized costs of the project (e.g., initial construction costs, replacement costs) are repaid by BPA over a 50 year period at designated interest rates. The current debt associated with the lower Snake River lock and dams is approximately $479 million for construction of the dams as of the end of 1998. In addition, there is also additional outstanding debt for the lower Snake River fish hatcheries and fish mitigation funds of approximately $271 million as of the end of 1998. There is also a construction work in progress account that will transfer to BPA as new additional debt.

If the lower Snake River locks and dams are removed, it is possible that Congress, through the authorizing legislation, will reduce some or all of this long-term debt. It is not known at this time what might be written off, however, this debt-relief is not considered an avoided cost. The debt cost is sunk and a write-off would not avoid it but rather would simply transfer the debt to a different party. The issue of payment of outstanding debt is addressed further under the finance section of the cost allocation report (Section 12).

3.8.7.2 Relationship of Implementation Costs to NED Impacts

Estimates of the NED impacts of power, navigation, recreation, water supply and other study elements are presented in Sections 3.1 through 3.7 of this appendix. Care has been taken to eliminate potential double counting of costs. As an example, the avoided cost report documents the cost to operate the lower Snake River lock and dams under various dam retention alternatives. A major portion of this cost is for power facilities. Including the cost to provide power from the four lower Snake River dams in the power cost estimates would lead to a double counting of costs. Therefore, the costs of operating the existing plants are excluded from the hydropower analyses. Care has been taken in evaluating other NED impact estimates to assure that double counting is similarly avoided.

The avoided cost estimates indicated above have focussed on Federal costs. However, there could also be impacts to state and local governments, private sector individuals and firms, and the Tribes. The NED impact estimates should account for the avoided costs to other parties that could partially offset national cost increases. There may, however, be some costs that have not been captured in other study elements. One example is the cost to reconstruct the natural gas line that crosses lake Herbert G. West (Lower Monumental Reservoir). Under the Alternative 4, Dam Breaching, this reconstruction is estimated to cost $12.4 million. The study teams have not captured this cost. There may be other examples.

3.8.8 Unresolved Issues

The engineering cost estimates in this report are preliminary and may be adjusted between the draft and final FR/EIS.

With respect to avoided costs, the hydropower group is evaluating whether the reduction of the Canadian entitlement should be considered as an avoided cost.

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4. Passive Use Values

Beneficial effects measured under the NED account include increases in the economic value of the national output of goods and services, the value of output resulting from external economies caused by the proposed alternatives, and the value associated with the use of otherwise unemployed or under-employed labor resources (WRC, 1983). Adverse effects are usually the opportunity costs of resources used in implementing a plan. These effects typically include implementation outlays, associated costs, and other direct costs.

The NED account addresses direct use value, which may be simply defined as the value that an individual derives from the direct use of a natural resource. Direct uses include "consumptive uses, such as fishing and hunting in which resources are harvested, and non-consumptive uses, in which the activity does not reduce the stock of resources available for others at another time, such as bird watching or swimming" (NOAA, 1994; p. 1,073). The unique characteristics of some resources have, however, caused some economists to question whether this type of analysis incorporates all of a resource's value. It has been argued that some individuals who are not directly using a resource might be willing to pay some amount of money just to know that the resource exists even though they have no intention of ever using it. Passive use or existence values of this type may be defined as "the values individuals place on natural resources independent of direct use of a resource by the individual. Passive use values include, but are not limited to: the value of knowing the resource is available for use by family, friends or the general public; and the value derived from protecting the natural resource for its own sake; and the value of knowing that future generations will be able to use the resource" (NOAA, 1994; p. 1,073). Passive use values are not included as part of the NED accounting stance.

The preservation of endangered species and free-flowing rivers are well recognized as possible sources of passive use value (Krutilla and Fisher, 1975; Meyer Resources, 1974, Randall and Stoll, 1983; Stoll and Johnson, 1984). Passive use values for Pacific Northwest salmon and steelhead populations may be motivated by the public's desire to preserve these species and their associated habitats for the enjoyment of future generations. These natural resources may be viewed as a significant component of what distinguishes the Pacific Northwest from other parts of the country. While a free-flowing river is arguably less symbolic of the Pacific Northwest, the public may still be motivated to return the lower Snake River to a free-flowing condition for the benefit of future generations even if they never visit or use it themselves. Passive use values are an example of what economists refer to as a public good—a good that can be simultaneously enjoyed by multiple consumers without diminishing its overall value. Recognizing the growing support for the use of passive use values in resource allocation analysis in the economics community, a passive use analysis was conducted as part of this project. This analysis estimates passive use values for both endangered salmon and steelhead stocks and also a free-flowing lower Snake River.

4.1 Passive Use, Contingent Valuation and Benefit-Transfer[1]

Passive use values for non-market goods cannot be estimated using market data because such goods are not exchanged in markets. Therefore, economists have turned to stated preference methods,

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[1] Much of this section and the preceding introductory discussion is excerpted from a technical memorandum prepared for the Multi-Species Framework (Kealy, 1999). This memorandum summarizes the current state of knowledge concerning passive use value and its measurement.

most notably, contingent valuation methods to measure passive use values. These methods generally use surveys of a representative sample of the relevant population to obtain expressions of a stated preference based on hypothetical market conditions. These stated preferences are then directly or indirectly used to determine willingness to pay for a good or service. This willingness to pay value is contingent upon the nature of the constructed market described in the survey scenario, hence the name "contingent value."

The contingent valuation method is controversial because of the difficulty of establishing the validity of the public's value statements and of determining the applicability of these value statements to the relevant policy decisions. The reliability and validity of contingent values depend upon the extent to which they precisely and accurately measure true values. Many economists are skeptical because they believe that the actual exchange of dollars for goods is fundamental to truthful revelation of preferences, or because results do not seem reasonable. Without an actual monetary transaction, people may lack the incentive to carefully research their preferences and may be overly influenced by information provided in a hypothetical exercise. While this influence theoretically should not affect their underlying values it very well might. Some experiments have shown that stated values are largely independent of the scale of the resource, that stated values are strongly related to the format of questioning, or that interpolation to numerous environmental goods implies unlikely or infeasible levels of payment. (See Hausman, 1993, for a critical assessment of contingent valuation.) Other studies, however, have shown that contingent values are sensitive to the scale of the good and that they are similar to (usually lower than) the value estimates obtained using other methods (Carson, 1997; Carson et al., 1996). The contingent valuation method has been given limited endorsement by a Blue-Ribbon panel chaired by two Nobel Laureate economists (Arrow et al., 1993). Many people believe that without an actual monetary transaction, respondents are likely to indicate they would pay more than they actually have in disposable income.

DREW originally requested that a passive use survey be conducted by the DREW Recreation Workgroup. This survey was designed and pretested. Controversy surrounding the pretest mailing and contingent valuation methodology prevented this survey from being conducted. Rather, passive use values were approximated using a benefit-transfer approach based on existing passive use value estimates. The benefit transfer approach is generally considered a practical alternative to valuation methods that involve the collection of original data on preferences. The benefit-transfer approach involves "transferring" existing studies, value estimates, and willingness to pay functions to new policy contexts, sites, and affected populations. The reliability and validity of such transferred values depend upon the quality of the original studies as well as the degree of similarity between the original context in which the values were estimated and the new policy context. At best, passive use values estimated using the benefit-transfer method can only be as accurate as the original studies on which they are based.

The passive use analysis conducted by the DREW Recreation Workgroup assumed that there are no passive use values associated with the existing lower Snake River dams and reservoirs. While it is possible that man-made objects such as dams may have existence value, economic theory and empirical evidence to date suggest that this is likely to be small (Lockwood et al., 1994). Scarcity and uniqueness are typically major determinants of the size of passive use values. Dams and reservoirs are not scarce in the Columbia River Basin or the Pacific Northwest. While dams and reservoirs are not scarce in the Pacific Northwest, the policy context that underlies this analysis is fairly unique. For some, the four lower Snake River dams are a planned manipulation of natural

resources representative of human and technological progress. For some individuals, breaching these dams may be regarded as a retreat from technological progress. These individuals may value the continued operation of the dams, even though they may not directly benefit or use the dams or reservoirs themselves. Most of the value of development, such as dams or barge transport, is believed to come from the market outputs created or the non-market recreation use values. Most public support for the dams can be traced to the economic or recreation benefits provided by dams and reservoirs. These direct use values are measured as part of the NED analysis presented in Section 3 of this document. A second source of public support for dams is the indirect local economic activity they generate. Local and regional indirect economic effects are addressed in the RED analysis presented in Section 6 of this document.

4.2 Salmon

Three approaches were used to transfer benefits from four existing studies to estimate the change in passive use value for lower Snake River salmon populations. While none of these existing studies precisely matches the policy setting of this study (which is why an original passive use value study was originally proposed by DREW), each provides an indication of the likely range of the passive use values for increasing salmon populations. All three of these approaches do a reasonable job of meeting the criteria for benefit transfer laid out by Boyle and Bergstrom (1992; 659). The criteria identified by Boyle and Bergstrom are as follows: "(1) the nonmarket commodity valued at the study site must be identical to the nonmarket commodity to be valued at the policy site; (2) the populations affected by the nonmarket commodity at the study site and policy site have identical characteristics; and (3) assignment of property rights at both sites must lead to the same theoretically appropriate welfare measures (e.g., willingness to pay versus willingness to accept compensation)." All four studies measure the same resource—salmon; three of the studies estimate passive use values for salmon in Washington State; and they all estimate these values based on the same measure—willingness to pay.

The existing studies do not perfectly match the policy setting of the Lower Snake River Juvenile Salmon Migration Feasibility Study because no reference is made to threatened or endangered species in the surveys used in these studies. This suggests that the margin of error associated with applying the results of these studies to the threatened and endangered stocks of the lower Snake River is likely to be in the conservative direction. It is likely that if the original surveys had specifically addressed threatened and endangered stocks, the resulting values per fish would have been higher because people would be willing to pay more to save a species they perceive to be near extinction. Second, most of the existing studies valued a larger increase in the number of salmon than is being evaluated in the lower Snake River study. The law of diminishing marginal returns suggests that consumers will value each successive unit of a good less than its predecessor. This suggests that the average marginal value per fish is inversely related to the number of fish being evaluated. Diminishing marginal existence values were found in the existing studies used for this analysis and confirmed in other economic literature. Taking a marginal value per fish from a study that valued a large increase and applying it to a smaller increase on the lower Snake River will also underestimate the value of that smaller increment.

The following sections discuss the three benefit-transfer approaches employed in this analysis. The first approach estimates a willingness to pay function from salmon based on the results from all four existing studies. The other two approaches each apply the results from just one of the four studies to the lower Snake River case..

4.1.1 Regression Approach

The first approach statistically estimates a willingness to pay function for salmon using incremental existence values per salmon calculated from four contingent valuation method studies of West Coast residents' willingness to pay for increasing salmon populations. The four original studies (Olsen, et al., 1991; Hanemann, et al., 1991; Loomis, 1996b; and Layton, et al., 1999) provided five estimates of the incremental value of an additional salmon (two estimates were obtained from Layton, et al). The regression function estimated from these five estimates has an explanatory power of 62 percent, and the number of salmon is significant at the 1 percent level, even given the limited degrees of freedom (see DREW Recreation Workgroup, 1999).

Using this function, the change in annual total passive use values with different levels of wild salmon and wild steelhead recovery was calculated for *non*-user households in the Pacific Northwest and California to avoid any double counting of passive use values and recreation use values. Data on wild salmon and steelhead run sizes were based on preliminary equal weight PATH data extrapolated by the DREW Anadromous Fish Workgroup (1999) to represent all Snake River wild stocks. The change in annual total passive use value is measured in terms of the change from Alternative 1, Existing Conditions, which formed the baseline for this analysis. Passive use values were calculated for Alternatives 2 through 4 by applying the regression function to the estimated change in wild salmon and steelhead populations associated with each alternative. The results of this analysis are presented in Table 4.1.

Alternative 4, Dam Breaching, is estimated to yield wild salmon and steelhead populations that are 66 percent more than those estimated under Alternative 1, Existing Conditions. Based on the regression approach this increase in stocks would result in a $879.3 million average annual increase in passive use values. Wild salmon and steelhead run sizes projected for Alternative 2, Maximum Transport of Juvenile Salmon, and Alternative 3, Major System Improvements, were lower than those projected for Alternative 1, Existing Conditions. As a result, there would be net annual reductions in passive use values of $9.54 million and $97.36 million under Alternatives 2 and 3, respectively (Table 4-1).

Table 4-1. Passive Use Value Analysis for Salmon (Average Annual 1998 Dollars) ($1,000)

Alternative	Average Annual Wild Return[1/]	Change from Alt. 1	Regression-Based Transfer[2/]	Elwha River Only[3/]	Transfer of 1999 Columbia River Estimates Only[4/]	
1	71,110				Stable Baseline	Low Baseline
2	70,682	-428	($9.54)	($1.28)	($0.60)	($4.58)
3	69,641	-1,469	($97.36)	($4.41)	($2.06)	($15.70)
4	118,571	47,461	$879.34	$142.30	$66.47	$508.40

1/ Average annual returns of wild salmon and steelhead are based on preliminary equal weight PATH data extrapolated by the DREW Anadromous Fish Workgroup to represent all Snake River wild stocks.

2/ This approach statistically estimated a willingness-to-pay function based on four existing studies (Olsen, et al., 1991; Hanemann, et al., 1991; Loomis, 1996b; and Layton, et al., 1999).

3/ This approach is based on values generated in the Elwha River study only (Loomis, 1996b).

4/ This approach is based on a stated preference survey of Washington residents (Layton et al., 1999). The stable baseline condition assumed that fish populations stabilized at current levels over the next 20 years. The low baseline condition assumed that populations declined over the next 20 years at the same rate as the previous 20 years.

4.1.2 Transfer of Elwha River Estimates

A second approach to calculating the passive use value involved matching the change in anadromous fish populations in Alternative 4, Dam Breaching, to the one existing study that valued a similar size change in salmon (Loomis, 1996b) rather than using the statistical function estimated from all four studies. The change in salmon runs evaluated in the Elwha River study was around 300,000, about six times the size of the net annual increase projected for Alternative 4, Dam Breaching (Table 4-1). This suggests that application of the Elwha River study results to the lower Snake River may be a reasonable benefit transfer. The fact that both projects involve dam removal and are located in the state of Washington further supports this reasoning.

The household value calculated from a nationwide survey of residents willingness to pay for salmon on the Elwha River was applied to non-user households in the Pacific Northwest and California. The value obtained for Washington residents in the Elwha study was applied to Washington non-user households. Ninety-three percent of this value was applied to residents in the rest of the Pacific Northwest and California. This adjustment is based on the results of the Elwha survey (Loomis, 1996a) which compared Washington residents' willingness to pay for salmon on the Elwha River with the amount that residents in the rest of the United States would pay for the same increase in salmon on the Elwha River.[2]

Applying the respective values per household to non-user households in the Pacific Northwest and California yields a gain in passive use value of about $142 million per year with dam breaching. The results of this analysis are presented for each alternative in Table 4.1. These may be considered conservative estimates for four reasons. First, the lower Snake River salmon are threatened and endangered, while the salmon returning to the Elwha were not endangered when the survey was written. This suggests that transferring the values from the Elwha River study to the lower Snake River case is likely to underestimate the passive use values for the lower Snake River's threatened and endangered salmon. Second, the change in salmon on the Elwha River is about six times that expected on the lower Snake River, which further reinforces the conservative nature of the passive use value per fish calculated from the Elwha due to diminishing marginal existence values. Third, limiting passive use values to non-user households assumes that users receive no passive use values, an unlikely situation. Finally, this analysis does not account for passive use value for households located elsewhere in the United States, despite evidence from the Elwha River study that such households do receive passive use values from salmon recovery and dam removal (Loomis, 1996a, 1996b).

4.1.3 Transfer of Columbia River Estimates

The third approach used just the most recent stated preference survey of Washington residents (Layton et al., 1999) to estimate the passive use value of increasing salmon on the lower Snake River. Layton et al.'s survey asked Washington residents to rate four different scenarios that involved three different generic stocks of fish species (freshwater, migratory, and saltwater) in two geographic areas (eastern and western Washington). This study was designed to estimate the value

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[2]Ninety-three percent is an average for the nation and includes residents in the eastern United States where willingness to pay was just 75 percent of the Washington value. Values in the rest of the Pacific Northwest and California were typically higher than 93 percent. Applying 93 percent of the Washington value to the rest of the Pacific Northwest and California may overstate the necessary downward adjustment (see Loomis, 1996b for a graph of the distance willingness-to-pay function for Elwha River salmon).

to Washington households of changes in fish populations in Washington waters for a full range of fish under a variety of conditions.

The Layton et al. survey was designed to value incremental changes in the various types of fish populations over time relative to baseline conditions. Uncertainty over future baseline conditions led the authors to use two different baselines in their survey, which were presented to a split sample of respondents. The low baseline condition showed populations declining over the next 20 years at the same rate as the previous 20 years. In the stable baseline condition, populations stabilized at current levels over the next 20 years. Given the diminishing marginal value of incremental gains in fish, the stable baseline condition resulted in lower values per fish than the low baseline condition. Layton, et al. found their estimated values per household were consistent with past passive use value studies of Loomis (1996) and Olsen, et al. (1991) using the non-declining future baseline. While the PATH salmon numbers assume a non-declining future, Columbia River Inter-Tribal Fisheries Commission (CRITFC) biologists, based on their evaluation of past trend data (Weber, 1999), suggest continued future declines.

The survey by Layton, et al. was conducted by mail and had a respectable response rate of 68 percent. The survey design included a budget reminder exercise which involved households having to determine how their household spending would change with a reduction in monthly income that was equal to the dollar amounts they were asked to pay for the four different fish programs. The authors conducted a statistical analysis of the survey results and calculated a value per household for a 50 percent increase in the number of eastern Washington/Columbia River migratory fish (e.g., salmon and steelhead), an increase of 1 million fish. An increase of 50 percent is comparable to the relative change in projected salmon and steelhead from Alternative 1, Existing Conditions, to Alternative 4, Dam Breaching. The resulting value is $119 per household annually for each additional 1 million salmon and steelhead. The average annual difference between Alternatives 1 and 4 is estimated to be 47,461 fish. This suggests that transfer of the Layton et al. value to the lower Snake River context would result in a conservative estimate due to diminishing marginal existence values. It should also be noted, however, that application of the Layton et al. value could represent an overestimate because this value includes both use and non-use values. Efforts were made to exclude those households with recreation use values to avoid double-counting these values.

This value from Washington residents was used for Washington, with 93 percent of it applied to households in the rest of the Pacific Northwest and California. This value is multiplied by the number of non-angler (e.g., non-user) households in the study region. Non-angler households were defined as those that do not hold fishing licenses. Households with a fishing license were assigned zero passive use value. This represents a conservative estimate because it assumes that all households holding fishing licenses would visit the lower Snake River. It also assumes that users receive no passive use value. Total willingness to pay was then divided by 1 million to identify the passive use value per fish. This value per fish was applied to the number of wild salmon and steelhead that would return under each EIS alternative to estimate the passive use values associated with that alternative. Using the Layton, et al. first scenario of an assumed stable future salmon population baseline, the annual gain from Alternative 1, Existing Conditions, to Alternative 4, Dam Breaching, is $66.47 million annually. Layton et al.'s declining future baseline results in an annual gain of $508 million, similar in magnitude to the regression estimate of $879 million (see Table 4-1).

4.3 Free-Flowing River

While a free-flowing river is arguably less symbolic of the Pacific Northwest, the public may be motivated to return the lower Snake River to a free-flowing condition for the benefit of future generations, even if they never visit or use it themselves. The DREW Recreation Workgroup estimated the passive use value for a free-flowing lower Snake River based on two existing studies. These studies measure the same resource—free-flowing rivers—but address rivers located in Colorado and the upper Snake River in Idaho. The survey populations are geographically limited to Colorado residents in the first case and residents of the immediately surrounding counties in the upper Snake River case. The policy context is also notably different than the lower Snake River study. Both of the existing studies are concerned with preserving free-flowing rivers, while the present analysis is concerned with restoring the lower Snake River to a free-flowing condition by removing existing structures.

Sanders et al. (1990) conducted a mail survey of the willingness of Colorado households to pay to preserve free-flowing rivers. The annual willingness to pay per household was $77 in 1983 dollars or $116 in 1996 dollars based on 51 percent response rate. Dividing this by the 555 miles being valued yields a value of 21 cents per mile. Multiplying this by the 140 miles of the lower Snake River yields a value per household of $29.40 per year per household. The rivers included in this list are all within Colorado and include the Yampa, Dolores, and Green rivers.

Another study was a contingent valuation method estimate of preserving the 63-mile-long Black Canyon of the upper Snake River by not allowing development (Scott and Wandschneider, 1993). The University of Idaho conducted telephone interviews of residents of the four Southeastern Idaho counties that surround this section of the river. This survey, conducted on behalf of the Bureau of Land Management (BLM), had a response rate of 76 percent and a sample size of nearly 350.

The upper Snake River survey indicated that the slightly more than half of this sample population who were non-users (n=196) had an annual willingness to pay of $58 for preservation of the upper Snake River (as compared to users who had a willingness to pay of $92). Dividing this value by the 63 protected miles yields a value of 92 cents per mile per household. This value is relatively high because only individuals living in counties adjacent to the river were sampled. This value per household per mile was applied to non-user households in the counties surrounding the lower Snake River. Thus a value of 92 cents times 140 miles or $129 was multiplied by the 305,467 non-user households located in the counties surrounding the lower Snake River. This resulted in a $39.4 million in passive use value for restoring a free-flowing lower Snake River. The Sanders et al. value of $29.40 was applied to the 12.95 million non-user households in the rest of Washington, Oregon, Idaho, Montana, and California, resulting in an estimated non-use value of $380.73 million for restoring the lower Snake River. Combining these two totals results in an aggregate passive use value for just the restoration of the free-flowing nature of the lower Snake River that is the sum of the two regions' values, or $420.13 million.

This value should be viewed with caution for at least two reasons. First, results taken from Colorado are applied to the entire Pacific Northwest and California with no allowance made for a possible distance willingness-to-pay function similar to the one that Loomis (1996a) identified for Elwha River salmon stocks. In addition, Colorado households may simply value free-flowing rivers differently than households in the Pacific Northwest and California. The difference in policy context—preservation versus restoration—may affect household willingness to pay. Some

households in the Columbia River Basin would be directly and negatively affected by breaching of the lower Snake River dams. They would experience loss of navigation and increased electricity rates, for example. This was not the case with the populations surveyed in the two existing studies. These types of direct use values would likely influence household passive use values for a free-flowing river.

4.4 Conclusion

The concept of passive use value is rarely challenged, but considerable controversy surrounds its measurement. The passive use values compiled in this study are not included in the NED account. The challenge in this study was to approximate passive use values based on the existing literature. Four studies, three of which valued salmon in the Pacific Northwest, were applied in different ways to estimate the passive use values of increases in salmon populations in the lower Snake River. The incremental passive use values for the increase in anadromous fish due to the dam breaching alternative ranges from a high of $879 million for households in the Pacific Northwest and California to a low of $66 million with a middle range between $142 and $508 million. These findings suggest that there is a passive use value associated with increases in wild Snake River salmon and steelhead stocks, but the wide possible range identified for this value—$66 million to $879 million—underlines the difficulty in estimating this type of value from benefit transfer.

The DREW Recreation Team also identified an annual passive use value of $420 million associated with returning the lower Snake River to a free-flowing condition, independent of any effect on salmon populations. Again, this analysis suggests that a passive use value likely exists. But this estimate should be viewed with caution because the existing studies on which it is based evaluated different geographic regions, and those studies were performed under a different policy context than this study. Additionally, the reader is cautioned regarding the uncertainty considering the validity of the public's value statements. Many believe that without an actual monetary transaction, respondents are likely to indicate they would pay more than they actually have in disposable income.

5.0 Tribal Circumstances

5.1 Overview

During thousands of years of development, the regional Native Cultures built subsistence-based economies. By the early 19th century, these cultures had a variety of effective ways for living in the unique environments of the Pacific Northwest. A variety of significant natural resources and habitats, such as riverine, lake, or other aquatic environments supported their subsistence-based economies. These subsistence-based economies were in turn bolstered by established trade, political and social networks, and alliances that served to connect the region's different cultures. In these societies, villages harvested local resources and hosted inter-band resource/trade centers in their own lands through mutually beneficial agreements and concepts of exchange. The Pacific Northwest salmon play an important role in Native American economies as commercial, ceremonial, and subsistence harvest.

There are 14 tribes in the study area. These tribes are listed in Section 3.6 of this appendix and described in Section 4.8 of the main FR/EIS and Section 5.7 of Technical Appendix Q, Tribal Consultation and Coordination. Each tribe is unique, however, many tribes have retained linkages over the years: through blood ties; in cooperative pursuit of salmon and other food; and through religion; sharing of languages, and similarity of treaties. Some of these tribes live further away from the Snake River drainage and are more separated from the immediate vicinity of the lower Snake River. Economic information is not available on all 14 tribes at this time, however, this FR/EIS does include a substantial amount of material drawn from a Tribal Circumstances and Perspectives report, prepared for this FR/EIS by a private contractor in association with the Columbia River Inter Tribal Fisheries Commission (CRITFC) (Meyer Resources, 1999). This report presents information that represents the viewpoints of four CRITFC tribes—the Nez Perce Tribe (Nez Perce), the Yakama Indian Nation (Yakama), the Confederated Tribes of the Umatilla Indian Reservation (Umatilla), and the Confederated Tribes of the Warms Springs Reservation of Oregon (Warm Springs)—together with the Shoshone-Bannock Tribes of the Fort Hall Reservation (Shoshone-Bannocks). These five tribes were selected for specific input because of their close cultural and economic links to the salmon. Impacts to tribal circumstances may be viewed in terms of tribal ceremonial, subsistence, and commercial harvest of salmon and tribal access to lands valuable to the tribes. These five tribes are referred to as the study tribes in the remainder of this section.

Dollar revenue is considered by the study tribes to be a severely limited indicator of tribal value that provides distorted impressions of the full impact on tribes. The study tribes emphasize that while revenue obtained from commercial sales of salmon provides important income to tribal peoples, it does not represent the greatest part of value that tribal peoples associate with salmon. As a result, the Tribal Circumstances and Perspectives report provides a qualitative assessment of the alternatives considered as part of this FR/EIS. The key findings of this qualitative assessment are summarized in this section. A much lengthier discussion is provided in the Tribal Circumstances and Perspectives report (Meyer Resources, 1999a). From the perspective of the WRC guidelines that inform the overall economic analysis conducted as part of this FR/EIS (see Section 1.3), this discussion is part of the environmental quality account, which addresses non-monetary effects on significant natural and cultural resources. The Tribal Circumstances and Perspectives report also addresses tribal circumstances from an environmental justice perspective. The environmental justice

portion of the Tribal Circumstances and Perspectives report is summarized in the section of the main FR/EIS that addresses disproportionate impacts to minority populations.

The majority of the statistics presented in this section are derived from the Tribal Circumstances and Perspectives Report (Meyer Resources, 1999). These statistics include comparisons of present social and economic well-being, estimates of historic and future tribal salmon harvest, and identify the loss of tribal lands. Information addressing sources of tribal income and the on- and off-reservation employment of tribal peoples was not available. As a result, the evaluation of the economic effects of the proposed alternatives on the study tribes is limited to information in the Tribal Circumstances and Perspectives report.

5.2 Present Circumstances of the Study Tribes

The Tribal Circumstances and Perspectives report states that the peoples of the study tribes cope with poverty, high unemployment, and high rates of death (cited as from 20 percent to more than twice the death rate for residents of Washington, Oregon, and Idaho). The Tribal Circumstances and Perspective report includes a table that compares the recent present well being of the Study Tribes with their non-tribal neighbors (reproduced here as Table 5-1).

The data presented in this table indicate that tribal unemployment rates range from 3 to 13 times higher than state averages. The higher portion of this range, derived by Meyer Resources (1999) from data compiled by the U.S. Bureau of Indian Affairs (BIA), is likely indicative of tribal employment during winter months and appears to reflect the seasonal employment of tribal members. Nevertheless, there is little doubt that tribal unemployment rates exceed those of their non-tribal neighbors. The data in Table 5-1 also indicate that study tribe per capita income is less than state averages. Finally, Table 5-1 suggests that the ratio of tribal death rates to non-tribal death rates ranges from 1.2 times to more than twice the state averages.

Table 5-1. Comparison of Present Wellbeing of the Study Tribes and Their Non-Tribal Neighbors

Indicator of Well-Being[1/]	Nez Perce Tribe	Shoshone - Bannock	Yakama Indian Nation	Umatilla	Warm Springs Tribes	State of Idaho	State of Oregon	State of Washington
Families in Poverty (%)	29.4	43.8	42.8	26.9	32.1	9.7	12.4	10.9
Unemployment[2/]								
US Census (%)	19.8	26.5	23.4	20.4	19.3	6.1	6.2	5.7
BIA (%)	62.0	80.0	73.0	21.0	45.0			
Per Capita Income ($000s)	8.7	4.6	5.7	7.9	4.3	11.5	13.4	14.9
Ratio of Tribal Death rate to Non-Tribal Death Rate[3/]	1.7	2.3	1.9	1.2	1.6			

1/ The data presented in this table are taken directly from the Tribal Circumstances and Perspectives report (Table 41). See the tribe by tribe sections in that report for further information.

2/ Census data (U.S. Bureau of the Census – 1990 Census of Population: Social and Economic Characteristics – American Indian and Alaska Native Areas) and BIA data (U.S. Bureau of Indian Affairs, 1995. Indian Service Population and Labor Force Estimates) are both included because Census data is more rigorous but tends to overestimate employment. BIA numbers are less rigorous but more likely indicative of Tribal Circumstances, particularly over winter months.

3/ These data derived in part from the Indian Health Service, various years, are age-adjusted.

Source: Meyer Resources, 1999 (Table 41).

The Tribal Circumstances and Perspectives report suggests that the following quotations provide a more graphic description of present tribal circumstances:

> The personal suffering and tragic lives of many (Indian) people are not revealed in the cold reports of tribal and Federal governments. It can, however, be seen and felt in the towns and the countryside—in the eyes of men and the despair of mothers, with few options for change. When you can no longer do what your ancestors did; when your father or mother could not do these things either; when they or you found little meaning in and limited access to the ways of mainstream culture—the power of 70 percent winter time unemployment, and 46 percent of the population below the poverty level, is visible throughout the Nez Perce landscape.
>
> (Central Washington University, 1991)

The Tribal Circumstances and Perspectives report states that tribal spokespersons are uncomfortable with statistical treatment of their peoples. They feel that such data sometimes elicits a "blaming the victim" reaction.

> I don't much like this talk of unemployment and poverty. Before the white man came, we had no such thing as poverty. We lived off the land. We fished, we hunted, we gathered roots and berries. We worked hard all year round. We had no time for unemployment.
>
> Poverty came with the Reservations. We were forced to live away from our salmon and our other resources. Our poverty is our lack of our Indian resources. These resources are being destroyed by the white man. That's what's causing our poverty.
>
> (Nathan Jim, Sr., Warms Springs Fish Commissioner)

5.3 Causes of Present Economic Circumstances for the Study Tribes

5.3.1 Losing Tribal Salmon

The study tribes have identified the salmon decline as a great loss to tribal peoples. According to the Tribal Circumstances and Perspectives report, current tribal salmon harvests above the four lower Snake River dams are less than 1 percent of pre-contact levels (Table 5-2). The Tribal Circumstances and Perspectives report states that the principal cause of historic reductions in tribal salmon harvest was preemption by competing non-Indian harvesters, and obstruction or denial of access to usual and accustomed fishing places—sometimes fenced off by non-Indian property owners. Many of these issues were eventually challenged in court. For further information on the tribal historical perspective see Tribal Circumstances and Perspectives report (Meyer Resources 1999).

The transformation of the rivers to produce electricity, irrigation for agriculture, navigation services, etc., has affected salmon populations, which in turn have affected tribal salmon harvest (ceremonial, subsistence, and commercial). The Tribal Circumstances and Perspectives report indicates that as each dam was constructed, the tribes objected, calling on the government to reconsider. The tribes' arguments that these actions were contrary to their Treaties with the United States were unsuccessful.

Table 5-2. Estimated Tribal Fish Harvests—Traditional Times to the Present (1000 lbs)[1/]

	Nez Perce	Shoshone Bannock[2/]	Yakama	Umatilla	Warm Springs
Estimated Pre-Contact Harvest[3/]	2,800	2,500	5,600	3.500	3,400
Estimated Harvest in the mid-1800s[3/]	1,600	1,300	2,400	1,600	1,000
Current Tribal Harvest[4/]	160	1	1,100	77 for both tribes	
Present versus Pre-Contact Harvests (%)[5/]					
Above lower Snake River dams	0.6	0.04	-	-	
Below lower Snake River dams	5.1	-	19.6	1.1	
Present versus mid-1800s Harvests (%)[5/]					
Above lower Snake River dams	1.0	0.08	-	-	
Below lower Snake River dams	9.0	-	45.8	3.0	

1/ These data are presented in pounds of fish which are not easily compared to other fish data presented in this FR/EIS in terms of numbers of fish.

2/ Shoshone Bannock estimates include harvests by Sho-Pai Duck Valley peoples.

3/ Pre-contact and mid-1800s harvest estimates are based on estimated annual per capita consumption figures multiplied by estimated population totals for the early and mid-1800s. The population and per capita consumption estimates used to derive these numbers are discussed for each tribe in the Tribal Circumstances and Perspectives report.

4/ The peoples of the Yakama, Nez Perce, Umatilla, and Warm Springs reservations all fish in Zone 6 on the mid-Columbia River. CRITFC maintains data on the total tribal Zone 6 commercial catch. The Yakamas and the Nez Perce also keep their own Zone 6 catch subtotals but the Umatilla and Warm Springs do not. The commercial component of the combined figure shown for the Umatilla and Warm Springs tribes was calculated by subtracting the Yakama and Nez Perce subtotals from the CRITFC total. The residual harvest not accounted for by the Yakama and Nez Perce estimates is assumed to be harvested by either the Umatilla or the Warm Springs. The totals presented in Table 4-2 include these commercial harvest totals along with estimated ceremonial and subsistence totals obtained from each tribe. These estimates are only approximate but the Tribal Circumstances and Perspectives report suggests that they may be considered accurate within a reasonable range of magnitude and sufficient to indicate that present day tribal harvests are less than estimated pre-contact and mid-1800 harvest levels.

5/ Only the Nez Perce fish both above and below the lower Snake River dams.

Source: Meyer Resources, 1999.

5.3.2 Losing Tribal Lands

The Tribal Circumstances and Perspectives report states that the five study tribes control 2.6 million acres of their original Reservation lands—only 22 percent of the lands reserved in their treaties with the United States. Nine million acres of original tribal lands, together with the wealth those lands produce, are no longer in the hands of the tribes or their members. The estimated extent of tribal lands from traditional times to the present is indicated in Table 5-3. This table is taken directly from the Tribal Circumstances and Perspectives report. The tribes are reported to believe that the transfer of tribal wealth associated with Reservation lands into non-Indian hands was based on many injustices. For more information on this viewpoint see the Tribal Circumstances and Perspective report (Meyer Resources, 1999).

Table 5-3. Estimated Extent of Tribal "Own Lands"—Traditional Times to the Present (in Thousands of Acres)

	Nez Perce	Shoshone Bannock	Yakama	Umatilla	Warm Springs
Tribal lands ceded to the United States by Treaty	7,500	E-NQ	10,400	6,400	9,400
Retained Treaty lands (1855)	7,500	-	1,600	510	578
Retained Treaty lands (1868)	-	2,000	-	-	-
Umatilla land retained after boundary "survey error"	-	-	-	245	-
Nez Perce land retained after "steal treaty" of 1863	760	-	-	-	-
Lands owned today[1/]	94	544	1,126	158	658
Percent of Treaty lands owned today.	1.2	27.2	70.4	31.0	100+

1/ Tribal lands owned today have been reduced from treaty times as a result of Dawes Act "surplusing" and sales, right-of-way takings, and other losses. Non-Indians often hold the highest valued lands within Reservation boundaries. Reservation lands held by Indians are often interspersed with lands held by non-Indians in a "checkerboard," exacerbating difficulties for tribal resource protection and economic development.

E-NQ = extensive, but not quantified.

Source: Meyer Resources, 1999 (page xiii).

5.3.3 Tribal Perception Concerning the Adverse Circumstances of the Study Tribes

The Tribal Circumstances and Perspectives report is the most current information we have available on tribal views. It indicates a tribal belief that non-Indians have taken most Treaty-protected assets of value from the tribes—particularly their lands, waters, and salmon. Quotations illustrating the cumulative effects of these actions from a tribal perspective are presented in the Tribal Circumstances and Perspectives report. For example:

> My heart cries for my people, cuz we are no more Indians... All our horses are gone. No more cattle. All the pastures, the land, the hillsides, taken up by the farmers, by the white man.... Every inch of tillable ground is taken up. Where our houses used to be, they tear that down, and they put wheat in there or peas right on every inch of the ground. And they've taken down all the fences, and they've plowed through there. These big farmers, they've got everything in the world. The (Indian) owners have nothing. And they've taken everything.
>
> Like I say, they've taken our land, they've taken our rivers, they've taken our fish. I don't know what more they want.
>
> (Carrie Sampson, Umatilla Elder)

5.4 The Present Importance of Salmon to the Tribes

Today, salmon remain connected to the core of tribal material and spiritual life. Faced with bleak present circumstances, the tribal peoples still look first to the salmon with hope of a better future. This perspective is illustrated by the following quotations taken from the Tribal Circumstances and Perspectives report:

> Traditional activities such as fishing, hunting and gathering roots, berries and medicinal plants build self-esteem for Nez Perce peoples—and this has the capacity to reduce the level of death by accident, violence and suicide affecting our people. When you engage in cultural activities you build pride. You are helped to understand "what it is to be a Nez Perce"—as opposed to trying to be someone who is not a Nez Perce. In this way, the salmon, the game, the roots, the berries and the plants are the pillars of our world.
>
> (Leroy Seth, Nez Perce Elder)
>
> The loss of the food and the salmon is monumental—and its all tied together. Food is a really big part of the Yakama culture—as it is elsewhere. Anywhere you look in the world, food carries culture. So if you lose your foods, you lose part of your culture—and it has a devastating effect on the psyche. You also lose the social interaction. When you fish, you spend time together—you share all the things that impact your life—and you plan together for the next year. Salmon is more important than just food.
>
> In sum, there's a huge connection between salmon and tribal health. Restoring salmon restores a way of life. It restores physical activity. It restores mental health. It improves nutrition and thus restores physical health. It restores a traditional food source, which we know isn't everything—but its a big deal. It allows families to share time together and builds connections between family members. It passes on traditions that are being lost. If the salmon come back, these positive changes would start.
>
> (Chris Walsh, Yakama Psycho-Social Nursing Specialist)
>
> Salmon are the centerpiece of our culture, religion, spirit, and indeed, our very existence. As Indians, we speak solely for the salmon. We have no hidden agenda. We do not make decisions to appease special interest groups. We do not bow to the will of powerful economic interests. Our people's desire is simple—to preserve the fish, to preserve our way of life, now and for future generations.
>
> (Donald Sampson, Umatilla)

5.5 Reservation of the Tribal Right to Harvest Salmon

Treaties and their interpretations have been recognized to hold certain reserved rights, one being the right to fish. The Tribal Circumstances and Perspectives report depicts a few of these treaties. These are identified in Table 5-4.

Table 5-4. Key Treaties between the United States and the Five Tribal Circumstances Study Tribes

Treaty	Signing Date	Present Tribal Organization
Treaty with the Yakama Tribe	June 8, 1855	Yakama Indian Nation
Treaty with the Umatilla Tribe	June 9, 1855	Confederated Tribes of the Umatilla Indian Reservation
Treaty with the Nez Perce Tribe	June 11, 1855	Nez Perce Tribe
Treaty with the Tribes of Middle Oregon	June 25, 1855	Confederated Tribes of the Warm Springs Reservations of Oregon
Fort Bridger Treaty	July 3, 1868	Shoshone-Bannock Tribes

Source: Meyer Resources, 1999 (page xvi).

Tribal negotiators were careful to protect their rights to harvest salmon and the other key resources they depended on for survival in their treaties. According to the Tribal Circumstances and Perspectives report, the following explicit protection can be found in each of the treaties of the Nez Perce, Yakama, Umatilla, and Warm Springs:

> Article 3: The exclusive right of taking fish in all streams, where running through or bordering said reservations, is further secured to said confederated tribes and bands of Indians, as also the right of taking fish at usual and accustomed places in common with the citizens of the Territory, and of erecting temporary buildings for curing them; together with the privilege of hunting, gathering roots and berries, and pasturing their horses and cattle upon open and unclaimed lands.

The Tribal Circumstances and Perspectives report also highlights the following article in the Fort Bridger Treaty between the United States and the Shoshone-Bannock:

> Article 4: The Indians herein named...shall have the right to hunt on the unoccupied lands of the United States so long as the game may be found thereon, and as long as peace subsists among the whites and the Indians on the borders of the hunting districts.

The Court in State of Idaho v. Tinno, (497 P.2d 1386) stated that, in Article 4, "to hunt" also meant "to fish."

The Tribal Circumstances and Perspectives report indicates that the intent of tribal negotiators during Treaty signings was to reserve the salmon resource for harvest from river systems that were biologically functional and fully productive. It has been opined that if the tribal treaty negotiators believed they were bargaining to reserve "only a small fraction" of the salmon available to harvest in the mid-1800's, the treaty negotiations would have been much different—if they had occurred at all.

It is also a tribal perspective that the treaty signers, both tribal and non-tribal, intended and designed the Treaties to take care of the needs of tribal peoples in perpetuity. Consequently, there is no date in time, subsequent to 1855 that cuts off tribal Treaty entitlements.

In conclusion, the study tribes maintain that they have an entitlement to a fair share of the salmon harvest from all streams in their ceded area(s). For further discussion on this issue, see the Tribal Circumstances and Perspectives report (Meyer Resources, 1999).

5.6 Effects of the Lower Snake River Dams on the Study Tribes

As stated in the biological sections of this FR/EIS, the four lower Snake River dams have played a part in the decline of the salmon. The tribes have been affected economically by the dams to the extent that the dams influence the decline of salmon and reduce the pounds of fish available to be incorporated into their present day economic circumstances. See the main FR/EIS for discussion of other impacts and the Tribal Circumstances and Perspectives report for tribal views.

At the same time, the lower Snake River dams have increased the wealth of the region through enhanced production of electricity, agricultural products, transportation services, and other associated benefits. The Tribal Circumstances and Perspectives report states that tribal peoples believe they have not shared in this increased wealth on a commensurate basis.

Construction of the four lower Snake River dams and reservoirs also inundated numerous river miles of privately-owned land that the Tribal Circumstances and Perspectives report asserts to be usual and accustomed tribal fishing areas. The historical connections between present tribal groups, original tribal groups, and the lower Snake River reservoirs are highlighted in Table 5-5, which is taken directly from the Tribal Circumstances and Perspectives report (Meyer Resources, 1999).

Table 5-5. The Relationship between Present Tribal Groups, Pre-Treaty Tribal Groups, and Flooding of Lower Snake River Reservoir Areas

Present Tribal Group	Original Tribal Groups in lower Snake River Territory	Associated Flooding by lower Snake River Reservoirs
Nez Perce Tribe	Nez Perce Indians living along the Clearwater River, and downstream along the lower Snake River to the Palouse River (north bank) and the Tucannon River (south bank)	Lower Granite, Little Goose, and Lower Monumental reservoirs
Yakama Indian Nation	Palous peoples living at the confluence of the Snake and Palouse rivers, and downstream along the north bank. Possibly other bands near the mouth of the Snake River.	Lower Monumental and Ice Harbor reservoirs.
Confederated Tribes of the Umatilla Indian Reservation	Palous people living at the confluence of the Snake and Palouse rivers, and downstream along the north bank. Walla Walla peoples living from the mouth of the Tucannon River downstream along the south bank of the Snake River.	Lower Monumental and Ice Harbor reservoirs.

Source: Meyer Resources, 1999 (Table 2).

5.6.1 The Alternatives and Their Impacts

The Lower Snake River Juvenile Salmon Migration FR/EIS considers future alternatives with respect to the four dams and their reservoirs, affecting about 140 miles along the lower Snake River and approximately four miles along the lower Clearwater River. The effects of the four proposed alternatives on salmon and tribal lands are discussed in the following sections.

5.6.1.1 Tribal Salmon Harvest

The Plan for Analyzing and Testing Hypotheses (PATH) measured the effect of the proposed alternatives on seven index salmon stocks. The discussion of alternatives presented below is based on preliminary PATH data weighted by PATH's panel of independent experts and extended by the

DREW Anadromous Fish Workgroup to represent all Snake River wild and hatchery stocks. The Tribal Circumstances and Perspectives report presents tribal harvest recovery rates based on this preliminary PATH data and converts these rates into pounds, assuming average weights of 20.1 pounds per salmon for spring and summer chinook, 19.1 pounds per salmon for fall chinook, and 8.5 pounds per fish for steelhead. Results are discussed below for the 30-year and 50-year benchmarks. It should be noted that the NMFS analysis uses more recent PATH data that is unweighted. These data presented in pounds of fish are not easily compared to other fish data presented in the FR/EIS in terms of numbers of fish.

Tribal harvest data are presented for wild salmon and steelhead only in Table 5-7. Data are presented for both wild and hatchery salmon and steelhead in Table 5-8. The Tribal Circumstances and Perspectives report suggests that these forecasts may be overestimates because the PATH analysis is built from present-day conditions and fails to incorporate long-term negative trends in Columbia River/Snake River stock sizes. The report also suggests that the year zero assumptions, which were developed by the DREW Anadromous Fish Workgroup (see Section 3.5 of this appendix), likely exceed PATH's present conditions by approximately 34 percent for spring/summer chinook, and 43 percent for fall chinook (Meyer Resources, 1999; 214). The following sections assess the effects of the proposed alternatives in terms of the change from the year zero estimates. In addition, following the Tribal Circumstances and Perspectives report, comparison is made with current study tribe harvests from all Columbia River/Snake River system steelhead stocks. The Tribal Circumstances and Perspectives report estimates that current study tribe harvest from all Columbia River/Snake River system steelhead stocks is about 1,338,000 pounds (Table 5-2).

Table 5-7. Estimated Tribal Harvest of Wild Snake River Stocks in Pounds by Species

Alternative/ Project Year	Spring/Summer Chinook (1000 lbs)	Fall Chinook (1000 lbs)	Summer Steelhead (1000 lbs)	Total (1000 lbs)	Total Change from Year 0 (1000 lbs)	Total Change from Year 0 (%)
Alternative 1, Existing Conditions						
0	10.7	8.9	13	32.6		
10	28.2	16.8	19	64	31.4	96.3
30	54.7	21.9	93.6	170.2	137.6	422.1
50	62.4	21.5	94.8	178.7	146.1	448.2
Alternative 2, Maximum Transport of Juvenile Salmon						
0	10.7	8.9	13	32.6		
10	26.8	16.8	18.4	62	29.4	90.2
30	46.1	21.9	90.7	158.7	126.1	386.8
50	48.2	21.5	91.1	160.8	128.2	393.3
Alternative 4, Dam Breaching						
0	10.7	8.9	13	32.6		
10	27.2	24.6	18.9	70.7	38.1	116.9
30	149.3	133.1	113.1	395.5	362.9	1,113.2
50	174.6	133.6	117.6	425.8	393.2	1,206.1

Note: The Tribal Circumstances and Perspectives report does not address Alternative 3, but the impacts of this alternative on tribal harvest are likely to be similar to those projected for Alternative 2.

Source: Meyer Resources, 1999 (Table 50).

Table 5-8. Estimated Tribal Harvest of Wild and Hatchery Snake River Stocks in Pounds by Species

Alternative/ Project Year	Spring/Summer Chinook ("000 lbs)	Fall Chinook ('000 lbs)	Summer Steelhead ("000 lbs)	Total ('000 lbs)	Total Change from Year 0 ('000 lbs)	Total Change from Year 0 (%)
Alternative 1, Existing Conditions						
0	20.6	36.2	255.7	312.5		
10	36.7	41.2	272.3	350.2	37.7	12.1
30	97	58.2	639.1	794.3	481.8	154.2
50	110.8	65.1	660.6	836.5	524	167.7
Alternative 2, Maximum Transport of Juvenile Salmon						
0	20.6	36.2	255.7	312.5		
10	35.3	41.2	269.9	346.4	33.9	10.8
30	82.4	58.2	606.2	746.8	434.3	139.0
50	86.4	65.1	618.3	769.8	457.3	146.3
Alternative 4, Dam Breaching						
0	20.6	36.2	255.7	312.5		
10	43.1	87.9	356.3	487.3	174.8	55.9
30	304.2	650.7	951.5	1906.4	1593.9	510.0
50	355	668	990.4	2013.4	1700.9	544.3

Note:
The Tribal Circumstances and Perspectives report does not address Alternative 3, but the impacts of this alternative on tribal harvest are likely to be similar to those projected for Alternative 2.
Source: Meyer Resources, 1999 (Table 50).

Alternative 1, Existing Conditions

Alternative 1 would maintain existing conditions with scheduled improvements. The Tribal Circumstances and Perspectives report states that this alternative offers a 35 to 42 percent probability that spring/summer chinook would be delisted after 48 years and limited hope of salmon recovery within a reasonable timeframe. Data presented in the Tribal Circumstances and Perspectives report indicate that the tribes would harvest 32,600 pounds of wild Snake River salmon and steelhead and 312,500 pounds of wild and hatchery Snake River salmon and steelhead at project year zero. Under Alternative 1 tribal harvest of wild salmon and steelhead would increase more than four times by the 30-year benchmark. The combined wild and hatchery tribal harvest would increase by about 1.5 times over this period. As noted above, the Tribal Circumstances and Perspectives report asserts that these estimates based on PATH preliminary estimates extended by the DREW Anadromous Fish Workgroup are too high. These numbers do, however, allow some comparison to be made between alternatives.

Alternative 2, Maximum Transport of Juvenile Salmon

Alternative 2 would produce lower stock levels than Alternative 1. The Tribal Circumstances and Perspectives report states that this alternative offers a 30 to 40 percent probability that spring/summer chinook would be delisted after 48 years and would be unlikely to meet tribal salmon recovery objectives within a reasonable timeframe. Tribal wild salmon harvests would increase by about 387 percent over estimated year zero totals by the 30-year benchmark, while the combined tribal wild and hatchery harvest would increase by about 1.4 times. According to the Tribal Circumstances and Perspectives report, tribal harvest of wild Snake River stocks under this alternative would be about 7 percent lower than under Alternative 1. Tribal harvest of wild and hatchery stocks taken together would be about 6 percent less than under Alternative 1.

Alternative 3, Major System Improvements

The Tribal Circumstances and Perspectives report does not address Alternative 3, but the impacts of this alternative on tribal harvest are likely to be similar to those projected for Alternative 2.

Alternative 4, Dam Breaching

The Tribal Circumstances and Perspectives report states that this alternative offers a 80 percent probability that spring/summer chinook would be delisted after 48 years and concludes that only this alternative would redirect river actions toward significant improvement of the cultural and material circumstances of the five study tribes. Tribal harvest of wild salmon could increase by more than 11 times over estimated year zero totals by the 30-year benchmark and 12 times by the 50-year benchmark under this alternative. Combined wild and hatchery salmon harvests would be about 5.1 and 5.4 times higher than current harvest levels at the 30-year and 50-year benchmarks, respectively. By year 50 estimated tribal wild and hatchery harvest would increase by about 1.7 million pounds — increasing current study tribe harvests from all Columbia/Snake system steelhead stocks by 2.3 times. This alternative would produce 2.4 times more tribal harvest of Snake River wild salmon and steelhead stocks than Alternative 1 (2.6 times more harvest than Alternative 2).

5.6.1.2 Impacts on Flooded Lands Important to Tribes

Alternatives 1 through 3

Under Alternatives 1 through 3, tribal people would continue to be separated from the grounds in which their ancestors are buried along lower Snake River stream sides and unable to care for their graves.

The four reservoirs prevent tribal fishing, hunting, and harvesting of roots, plants and berries at some usual and accustomed stream side locations. These reservoirs prevent the subject tribes from holding religious and cultural ceremonies at locations that are below the present-day water levels.

The dams and reservoirs inundate lands associated with the substantial aspects of cultural, material, and spiritual life along the lower Snake River for affected tribal peoples — and separate tribal peoples from those areas.

Alternative 4, Dam Breaching

This alternative would drain the four lower Snake River reservoirs, and could potentially create substantial benefits for affected tribes. According to the Tribal Circumstances and Perspectives report, the study tribes feel that this would allow tribal peoples to renew their close religious/spiritual connection with approximately 34,000 acres of lands where their ancestors lived and are buried, and allow them to properly care for their grave sites. They could return to more than 600 to 700 locations where they were accustomed to live; fish; hunt; harvest plants, roots and berries; conduct cultural and religious ceremonies; and pursue other aspects of their normal traditional lives.

Tribal benefits associated with lands that are presently inundated could be obtained under Alternative 4, Dam Breaching, in the following ways if these actions were implemented:

- By restoring Treaty-based tribal access rights to usual and accustomed fishing places along the restored river sides.
- By restoring Treaty-based tribal access rights to hunt and gather on ceded, open, and unclaimed public lands alongside the restored river sides.
- By making it possible to return any tribal individual allotment lands in the reservoir area, acquired by the Federal government when the reservoirs were built, to tribal hands (i.e., to the Native American families that may have held any such allotments).
- By making it possible to transfer uncovered reservoir lands to tribes. (Congressional legislation would be needed for implementation of this action.)

5.7 Cumulative Tribal Impacts of Lower Snake River Project Alternatives

In conclusion, the Tribal Circumstances and Perspectives report restates the view that Alternative 4, Dam Breaching, is the only viable alternative for restoring the tribal fishery and providing other benefits to the tribes.

Alternatives 1 through 3

The tribes feel that under Alternatives 1 through 3, the lower Snake River would continue to function at present levels, continue tribal losses of treaty-protected salmon due to the dams, and, therefore, maintain the distribution of benefits from the river primarily to non-tribal hands.

Alternative 4, Dam Breaching

The study tribes believe that selection of Alternative 4, Dam Breaching, which would involve returning the lower Snake River to a free-flowing condition, would have the opposite effect on cumulative trends along the lower Snake River. Study tribes state it offers more than twice the tribal harvest projected under the other alternatives and would increase current study tribe harvests from all Columbia River/Snake River system salmon and steelhead stocks by 2.3 times. It would remove waters presently covering some 140-plus miles of shoreline and create access to important usual and accustomed tribal locations along the lower Snake River. For additional tribal views on impacts associated with flooding at lower Snake River reservoirs see the Tribal Circumstances and Perspectives report (Meyer Resources, 1999, Table 53).

According to the Tribal Circumstances and Perspectives report, from a cumulative policy perspective, the study tribes see selection of Alternative 4, Dam Breaching, as reversing an almost century and one-half trend which cumulatively stripped the tribes of their valued and treaty-protected assets, and would move toward "rebalancing" distributions of the wealth that the lower Snake River can produce between the tribes and non-tribal peoples of the study area. Such actions may not result in immediate improvements to tribal material well-being and health, but the Tribal Circumstances and Perspectives report states that over future years, as the salmon stocks become stronger, so would the health and economic well-being of tribal members.

The study tribes conclusions, as reported in the Tribal Circumstances and Perspectives report, with respect to the cumulative impact of lower Snake River Project alternatives on distribution of wealth, tribal health and material well-being, tribal spiritual and religious well-being, and tribal self-sufficiency and self-empowerment are summarized in Table 5-9.

Table 5-9. Summary of Cumulative Tribal Impacts from Lower Snake River A1, A2, and A3 Alternatives

Tribal Impact	Alternative 1	Alternatives 2 and 3	Alternative 3
Wealth Distribution	Non-tribal interests continue to accumulate wealth. Tribal loss of valuable assets continues.	Same as Alternative 1, but slightly more adverse.	Begins rebalancing the river's production function. Some wealth transfers from non-Indian interests back to the tribes begin as inundated lands are exposed and salmon is restored.
Health and Material Well-being	Will continue to preempt tribal subsistence and economic activity. Will continue adverse effects on tribal nutrition and general health.	Same as Alternative 1, but slightly more adverse.	Will begin reversal of adverse cumulative nutrition and health circumstances. Will reduce tribal poverty over time. Will broaden the base for tribal subsistence and, where appropriate, tribal economies.
Spiritual/ Religious Well-being	Continues to endanger the salmon, one of the key elements that provide religious, spiritual, and cultural definition for the study tribes.	Same as Alternative 1, but slightly more adverse.	Will remove salmon from endangerment. This will generate major benefits for key elements of tribal religion and spirituality, which will be removed from endangerment as well.
Tribal Empowerment	Continues to discount the knowledge and recommendations of tribal peoples concerning survival of Snake River salmon, disempowering the tribes.	Same as Alternative 1.	Credits the knowledge and advice of tribal peoples on what is required for the Snake River salmon to survive and recover. This would increase feelings of empowerment and self-worth among tribal peoples.

Source: Meyer Resources, 1999 (Table 54).

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6. Regional Economic Development (RED) Analysis

6.1 Introduction

Regional economic analysis is concerned with changes in the local economy that would be created by the alternatives. The NED sections of this appendix (Section 3) have discussed the direct economic effects that the proposed alternatives would have on power, transportation, water supply, and other aspects of the national economy. Increased or reduced spending associated with these changes would also affect the regional economy. These effects would be larger than those directly associated with the initial change in spending because direct changes in one sector of the regional or local economy have indirect and induced effects on other sectors. An influx of funds, for example, is spent and re-spent in the local economy as expanding sectors hire labor and buy business inputs and services from local suppliers. This process is known as the multiplier effect. The more locally produced goods and services purchased, the larger the multiplier effect. A reduction in spending also has indirect and induced effects. Closure of a business in a particular community, for example, has predictable impacts on other firms located in that community. Loss of a business results in less local spending of workers' wages and salaries, and less local spending for business inputs and services, therefore, making the total impact to the economy larger than the initial change.

The regional economic analysis developed for this study addresses the regional economic impacts of changes in spending projected by various DREW workgroups. These impacts, evaluated in terms of business sales, employment, and income, were estimated using input-output models, which model the interactions among different sectors of the economy. Business sales are the estimated gross receipts received by a business (with the exception of those businesses in the trade sectors where it is the margin or the value added by that business). Business sales are the driving force behind the economy from an input-output modeling perspective. Employment is measured in full-time and part-time jobs. Jobs are usually viewed as the single most important outcome of increased business sales and the greatest concern when economic growth falters. Personal income, the third measure used here, consists of wages, salaries, social insurance, and profit received by individuals.

The impacts to regional business sales, employment, and income summarized in the following sections are presented as net changes from existing conditions. The DREW Regional Analysis Workgroup projected changes to employment and income over a 100-year study period. Job totals include both full-time and part-time employment. The economy of the lower Snake River study area and the Pacific Northwest as a whole has changed since 1970. Historically important job sectors such as logging, mining, and farming and ranching have declined or remained stagnant over this period, while employment in the services sector has dramatically increased. Non-labor sources of income, particularly transfer payments, have increased as a component of total regional income. Employment is projected to increase over the next 20 years in the lower Snake River study area. These projected increases and the evolving structure of the regional economy form a backdrop against which changes in employment projected for the proposed alternatives should be considered. Although resource-based industries, such as logging and farming, will likely decline as a share of total employment at a state-level, they will remain important parts of the region's economic base,

especially in counties and communities where they are the dominant form of economic activity. Projected job changes may represent a small percentage of existing and projected employment, but the loss of these jobs could be significant for the counties and communities where they are concentrated. Potential effects to local communities are discussed in the DREW Social Analysis report (DREW Social Analysis Workgroup, 1999) and Section 7 of this appendix.

The remainder of this section is divided into four parts. Section 6.2 provides a brief discussion of the input-output methodology employed for this analysis. Section 6.3 presents the results of this analysis by resource area. In many cases only Alternative 4, Dam Breaching, creates economic change sufficiently large to warrant measurement. The impacts are summarized across the three measures employed in this analysis—business sales, employment, and income—in Section 6.4. Section 6.5 discusses remaining unresolved issues associated with this study. The main component of this section is a qualitative discussion of potential impacts to regional industries that could not be addressed quantitatively using the input-output methodology.

6.2 Input-Output Methodology

Input-output models estimate the effects of changes in one sector on the rest of the regional economy. Input-output is an accounting system that includes all the industries in a study region. The input-output accounts measure the interdependence among industries and workers in an economy. The greater the interdependence among industry sectors, the larger the multiplier effect on the economy (and jobs) if a local industry makes sales to persons or firms outside the region or to government. The input-output technique is a model of sales flows among industries and government agencies that is based on historical purchase patterns for each industry and for consumers. The input-output model simultaneously considers the interdependent spending changes among industries in the region that provide goods as inputs (the indirect effects), and households in the region that provide labor and management services to directly and indirectly affected industries (the induced effects).

Sales to final demand are the portion of an industry's sales that are for export (from the defined study region), sales to government, or to create new physical investment. Sales to final demand are an important measure because they are the driving force that supports the economy. Exports, sales to government, or sales for investment (i.e., new physical capital or addition to inventory) are the only sources of new spending for a regional economy. In this analysis, the primary changes in final demand sales are sales to Federal government and exports. Sales to final demand have a multiplier effect on the economic activity of a region because the expanding sector buys local labor and other inputs from local suppliers to create added output. Local suppliers must increase their purchases, spreading the expansion throughout the economy.

Each alternative has positive or negative changes in sales to final demand (including changes in government spending, changes in output of affected industries, and physical investments by private enterprise) which create indirect and induced changes in business sales, employment, and personal income in the study regions. These economic changes are shown by input-output multipliers that are applied to the change in sales to final demand to calculate the cumulative economic effects throughout the economy of a region. The secondary impacts for some industries are mainly local while other industries' impacts would occur at locations throughout the Pacific Northwest.

Economic changes created by the alternatives can be "short-run" or "long-run." Short run is used in this section to describe the effects of construction or other temporary spending that lasts for less than 10 years. In contrast, long-run effects are permanent and continue for the 100-year period analyzed in this study.

6.2.1 Limitations of the Analysis

Regional economic effects are measured in this analysis using input-output models with industry spending coefficients estimated or synthesized from national data rather than from surveys of local industry. These models were constructed based on the 1994 IMpact analysis for PLANning (IMPLAN) computer system originally developed by the U.S. Forest Service. The IMPLAN model is now being offered for general use by the Minnesota IMPLAN Group. This system can be used to construct county or multi-county models for any region in the United States. The regional models constructed by the Forest Service are based on technical coefficients from a national input-output model and localized estimates of total gross outputs by sector. IMPLAN adjusts the national level data to fit the economic composition and estimated trade balance of a chosen region. Some valid criticisms have been directed at synthesized input-output as opposed to survey based input-output. First, the synthesized industry spending coefficients are based on relationships between industries on a national scale. These generalized relationships may not apply to the specific region under study. An input-output model, unlike many other economic models, is constrained and consistent. The model is a double-entry bookkeeping system of accounts. Total sales must equal total purchases in each sector and for the economy as a whole and including imports and exports from the study region. A 90-industry input-output model (as used in this study) is equivalent to a sales maximizing linear program with 90 constraint equations that limit the outcomes. These built-in constraints limit most input-output models business sales multipliers (direct, indirect, and induced effects) to lie between 1.5 and 3.00 regardless of the underlying data source. Recent IMPLAN models, which use much more refined data than earlier models, are typically within plus or minus 10 percent of the multipliers that would be found using survey data in place of national averages. This conclusion is based on experience with constructing about 30 direct survey input-output models. Furthermore, IMPLAN contains known sources of error that have been adjusted (DREW Regional Analysis Workgroup, 1999).

One limitation of this type of regional impact analysis is that it presents a picture of the economy at a single point in time. This picture is based on historical ratios between different sectors of the economy rather than a dynamic structure of changing relationships. When prices or costs change in response to public policy changes, consumers, and producers respond by substituting among final goods, substituting among inputs to production, migrating among regions, and shutting down businesses that are no longer profitable. To evaluate these sorts of changes, economists must first use supply and demand models to estimate the direct effects, which are then used to drive the input-output model. Accurate estimates of regional change are dependent upon the projections of direct effects by sector that drive the input-output modeling.

It has also been suggested that this type of regional analysis tends to overstate long-term impacts because it assumes that all possible adjustments to disturbance are instantaneous and permanent, and that individual responses to disturbances are limited. People who lose jobs, for example, are assumed to stay unemployed. In reality, people and businesses adjust over time, as they consider and try alternative occupations, technologies, and locations (IEAB, 1999).

6.2.2 Study Regions

Eight input-output models were constructed to address potential regional effects associated with the alternatives. Models were developed for Washington, Oregon, Idaho, and Montana, the downriver, reservoir, upriver subregions, and the lower Snake River study area, which consists of the three subregicns (see Table 6-1 and Figure 1-1). The downriver subregion is defined as the region that would be the terminus of barge transport under Alternative 4, Dam Breaching. The reservoir subregion, which consists of those counties that adjoin the four lower Snake River reservoirs, would see changes in barge transport and gain free-flowing river recreation under Alternative 4, Dam Breaching. The upriver subregion is defined as the region in central Idaho and northeast Oregon that would lose barge transport and gain free-flowing river recreation and increased fishing opportunities.

Table 6-1. Regional Economic Analysis Study Area by State and County

Downriver Subregion	Reservoir Subregion	Upriver Subregion
Oregon	**Washington**	**Idaho**
Gilliam	Adams	Clearwater
Hood River	Asotin	Custer
Morrow	Columbia	Idaho
Sherman	Garfield	Latah
Umatilla	Walla Walla	Lemhi
Wasco	Whitman	Lewis
		Nez Perce
Washington		Valley
Benton		
Franklin		**Oregon**
Klickitat		Wallowa
Skamania		

The subregion models were developed to examine cases, such as a reduction in irrigated agriculture on Ice Harbor Reservoir, where impacts are relatively localized. Evaluating localized changes using a statewide model would tend to overestimate the impact. States are less dependent on imports than smaller regions and, therefore, tend to have larger multiplier effects. The state models are used to evaluate impacts, such as increases in electric rates, that occur at a larger scale.

In addition, the DREW Anadromous Fish Workgroup used a Fishery Economic Assessment Model (FEAM) based on IMPLAN technical coefficients to estimate the economic impacts of changes in anadromous fish harvests. These impacts were evaluated for the states of Washington, Oregon, and Alaska, and for British Columbia, Canada.

6.3 Economic Impacts by Resource Category

This section shows the direct, indirect, and induced regional economic effects of the proposed alternatives by resource category. Employment changes projected by the 1994 IMPLAN model were divided by 1.07 to adjust for inflation when using final demand changes of the alternatives that were in 1998 dollars. The IMPLAN model projects employment on the basis of jobs per dollar of sales in 1994. Thus, without this adjustment, inflation would cause projected changes in jobs to be overstated. All impacts are shown in 1998 dollars. Readers are referred to the DREW Regional

Analysis Workgroup (1999) report for a more detailed discussion of the methodology and findings of this analysis.

6.3.1 Power

6.3.1.1 Potential Rate Increases

Alternative 4, Dam Breaching, would terminate hydroelectric generation at the four Corps dams on the lower Snake River. This would lead to a need for replacement power generation. The capital costs for constructing the new power plants and the increased operating costs for these plants would lead to increased electricity bills to ratepayers. In addition to increased power generation costs, there is also the question of how the costs of implementing the alternatives will be distributed. It is not possible to say how the costs associated with Alternative 4, Dam Breaching, would ultimately be paid. Before restructuring of the electricity industry, a large portion of the costs would have been BPA's responsibility and BPA would have raised its rates to recover increased costs. In a restructured, competitive, wholesale power market, the price that BPA can charge its customers is effectively capped by the market price of electricity. BPA can no longer recover higher costs by raising its rates because utilities that buy power from BPA now have alternate sources of electricity supplied by the wholesale electricity market. A number of possible cost allocation scenarios exist ranging from BPA customers through the entire Pacific Northwest load. This is discussed further in the financial analysis presented in DREW Hydropower Impact Team (1999).

Increased electric rates may cause customers to switch from electricity and increase the demand for natural gas, propane, fuel oil, and insulation. Over time, more efficient household, commercial, and industrial electric appliances, machines, and processes would be substituted for electricity use. The long-run demand for electricity has been shown to be sensitive to price increases. As a result, increasing the price per kilowatt-hour (kWh) consumed would reduce the amount of electricity that must be produced and increase the demand for substitute products. If the increased electric bill were paid by an increased fixed monthly charge as opposed to a rate increase, the substitution effects would be minimal because few customers would be willing to give up their electricity connection.

Electric bill increases would reduce net income for industries and reduce disposable income for households in the region. The extent to which business firms would leave the region or reduce output and employment in reaction to reduced net income is unknown. Some industries may be able to pass part of the increased electric bill on to their customers. Other industries, such as agriculture, cannot do this because of intense national or global competition. Higher electric bills paid by residential consumers, farmers, and business owners would reduce their disposable income, leading to reduce consumer spending for other goods and services. Projected increases in annual electricity expenditures are presented by state and sector in Table 6-2.

The economic impact of increased electricity bills on the aluminum sector is unknown because information is not available to predict the effects of increased operating costs on production and employment. The aluminum processing sector could be severely impacted. Based on their share of current electricity use, aluminum plants in Washington would have an increase in their annual electricity bill of $26 million, while plants in Oregon would have an increase of $12.88 million, and plants in Montana would have an increase of $4.58 million (Table 6-2).

Table 6-2. Annual Electricity Expenditure Increases Caused by Alternative 4, Dam Breaching by State and Sector, (1998 dollars) (Million Dollars)[1/]

	State							
Sector	**Wash.**	**Ore.**	**Idaho**	**Mont.**	**Cal.**	**Nev.**	**Wyom.**	**Total**
Commercial	39.45	24.88	8.49	1.78	0.45	0.07	0.14	72.56
Industrial[2/]	35.24	22.35	12.44	5.10	0.22	1.08	0.27	76.70
Irrigation	3.39	1.74	4.06	0.12	0.18	0.01	0.01	9.51
Residential	53.94	30.26	12.26	2.38	0.71	0.82	0.41	100.78
Aluminum	26.00	12.88	0.00	4.58	0.00	0.00	0.00	43.46
Federal	2.67	0.00	0.00	0.00	0.00	0.00	0.00	2.67
Total	**160.69**	**92.11**	**37.25**	**13.96**	**1.56**	**1.98**	**0.83**	**308.38**

1/ Electricity spending increases are distributed to sectors based on the existing spending shares.

2/ These totals exclude the aluminum industry which is shown in a separate row below.

Source: DREW Hydropower Impact Team (1999).

Impacts on Residential and Farm Incomes

Increased electric bills to residential and farm irrigation customers are assumed to be paid by households and create a reduction in disposable income to households. The cost to individual households would rise by approximately one to six dollars depending on how many ratepayers were subject to the rate increase. The direct, indirect, and induced economic effects of reduced household income in the States of Washington, Oregon, Idaho, and Montana are estimated using input-output models for these four States. Alternative 4, Dam Breaching, is the only alternative that would create a significant changes in household electricity bills. Table 6-2 shows the projected increase of electricity bills for residential and farm irrigation customers based on current consumption patterns (DREW Hydropower Impact Workgroup, 1999).

Increased electric power bills paid by residential and farm households would cause household personal income to fall in the states of Washington, Oregon, Idaho, and Montana. Initial decreases in personal income were multiplied by each state's input-output multipliers to identify their impacts on state business sales, employment, and personal income. These results are presented by state in Table 6-3.

Impacts on Local Owners of Commercial and Industrial Firms

Although the effects on the viability and operating levels of electricity-intensive firms and plants are unknown, the effect on the personal income of in-state owners of many small commercial and industrial firms can be estimated (primary aluminum is excluded because it is not a locally owned small business). Projected increase in electricity bills for commercial and industrial firms are presented in Table 6-2. Based on unpublished payroll data, a rough estimate of in-state ownership for commercial and industrial firms is 50 percent and 30 percent respectively (precise estimates would require knowledge of electricity consumption by many individual firms and industries). Thus, the commercial row of Table 6-2 was multiplied times 0.5 and the industrial row times 0.3 to find the increased electricity bills paid by in-state owners if Alternative 4, Dam Breaching, were selected. These estimates of increased electricity bills to local owners of commercial and industrial establishments are treated as reductions of their spendable personal income.

Table 6-3. Annual Regional Effects of Increased Electric Bills to Residential and Farm Irrigation Customers under Alternative 4, Dam Breaching (1998 dollars) 1/

	Initial Reduction in Household Personal Income ($ million)	Business Sales (1998 $ million per year)	Employment	Personal Income (1998 $ million per year) 2/
Washington	(57.32)	(134.56)	(743)	(78.39)
Oregon	(32.00)	(80.52)	(507)	(45.81)
Idaho	(16.32)	(37.10)	(248)	(22.22)
Montana	(2.50)	(5.26)	(36)	(3.11)
Total	(108.14)	(257.44)	(1534)	(149.53)

1/ The impacts shown above are for the "middle" estimate of the change in electric bills. The effects of the "low" estimate can be found by dividing these results by 1.284. The effects of the "high" estimate can be found by multiplying the results shown above by 1.241 (DREW Hydropower Impact Team, 1999).

2/ The multiplier effect results in personal income decreasing by a multiple of the original change.

Increased electric power bills paid for commercial and industrial uses would cause household personal income to fall in the states of Washington, Oregon, Idaho, and Montana. Initial decreases in personal income were multiplied by each state's input-output multipliers to identify their impacts on state business sales, employment, and personal income. These results are presented by state in Table 6-4.

Table 6-4. Annual Regional Effects of Increased Electric Bills to Local Owners of Commercial and Industrial Firms under Alternative 4, Dam Breaching (1998 dollars) 1/

	Initial Reduction in Household Personal Income ($ million)	Business Sales (1998 $ million per year)	Employment	Personal Income (1998 $ million per year) 2/
Washington	(30.30)	(71.13)	(393)	(41.43)
Oregon	(19.15)	(48.18)	(303)	(27.41)
Idaho	(7.79)	(17.71)	(118)	(10.61)
Montana	(2.43)	(5.11)	(34)	(3.09)
Total	(9.67)	(142.13)	(848)	(82.54)

1/ The impacts shown above are for the "middle" estimate of the change in electric bills. The effects of the "low" estimate can be found by dividing these results by 1.284. The effects of the "high" estimate can be found by multiplying the results shown above by 1.241 (DREW Hydropower Impact Team, 1999).

2/ The multiplier effect results in personal income decreasing by a multiple of the original change.

6.3.1.2 Hydroelectric Operation and Maintenance

Alternative 4, Dam Breaching, would result in shut down of hydroelectric generation at the four lower Snake River dams. Reduced operation and maintenance costs (the plants require security and preservation services after shut down) would create negative direct, indirect, and induced economic impacts on the region. These impacts are included in Section 6.6.6 of this appendix.

6.3.1.3 Power Plant Construction

It is assumed that six new 250-megawatt (MW) combined-cycle, gas-fired electric power plants would be constructed to replace the lower Snake River dam power output. Two of the six plants are needed to support system reliability. Three new combined-cycle plants are expected to be constructed in the downriver subregion. The first two plants would potentially be constructed in 2007 and go on line in 2008. It was assumed that the first two plants would be constructed in Hermiston and Tri-Cities. It is estimated that a third plant would be built in 2008 in Tri-Cities. Three more plants could be constructed in the Puget Sound region. These plants could be constructed in 2009, 2010, and 2016, respectively (DREW Hydropower Impact Team, 1999).

Each plant is assumed to take one year to construct. Plant construction costs are estimated to be $601,000 per megawatt or $150.25 million per plant. These costs would be incurred during the year of construction in each case. Based on the downriver subregion utility construction multipliers, each one-year construction project would generate business sales of $332.40 million, 2,786 jobs, and an increase of $104.80 million in personal income. These impacts would be doubled in 2007 because two plants could be constructed simultaneously. Similar construction impacts can be expected in the Puget Sound area.

6.3.1.4 Power Plant Operation

According to BPA power system modeling, the new combined-cycle plants would operate at 90 percent of their design capacity. Operating costs of the new plants are estimated to be $13.61/megawatt hour (MWh) resulting in an annual operating cost of $26.80 million per year. Six new plants would generate operation spending of $160.80 million per year. This operation spending would be distributed between labor (households) and labor-intensive services (21 percent), and the natural gas production, transmission, and distribution sector (79 percent). This division was based on information on combined-cycle plants (DREW Hydropower Impact Team, 1999).

Annual spending increases in the lower Snake River region to operate the plants would be $53.60 million ($26.8 million times 2) per year in 2008 and $80.40 million ($26.8 million times 3) per year in 2009 and thereafter. Annual spending increases in the Puget Sound region would be about $26.8 million per year in 2010, $53.60 million per year in 2011, and $80.40 million per year in 2017 and thereafter. The shortfall of power generated in the region would require electricity imports to the region prior to the construction of the new plants. It is assumed that these temporary electricity imports would not create any measurable changes in spending or employment within the study region.

While the three plants that would be constructed in the lower Snake River region would be located in the downriver subregion, the adjacent reservoir subregion could also be affected by construction activities. Thus, the Lower Snake River Model was used to estimate impacts. Operation and maintenance spending on labor and labor-intensive services associated with the first two plants would be about $11.26 million. Based on lower Snake River study area multipliers this would generate $26.70 million in business sales, 168 jobs, and $4.16 million in personal income. These effects would occur annually starting in 2008. Completion of the third plant in 2009 would increase these annual impacts to $40.05 million in business sales, 252 jobs, and $6.24 million in personal

income. The remaining three combined-cycle power plants would add to the impacts in a similar manner in the Puget Sound area in 2010, 2011, and 2017.

The major input to this type of power plant is natural gas. Natural gas would account for $42.34 million per year of purchases from the gas distribution sector for the first two plants. Based on lower Snake River study area multipliers, this would generate $67.10 million in business sales, 416 jobs, and $11.56 million in personal income. These effects would occur annually starting in 2008. Completion of the third plant in 2009 would increase these annual impacts to $100.65 million in business sales, 624 jobs, and $17.34 million in personal income. The remaining three combined-cycle power plants would add to the impacts in a similar manner in the Puget Sound area in 2010, 2011, and 2017.

6.3.1.5 Transmission Line Construction

A total construction expenditure to modify electricity transmission lines of $177 to $271 million would occur over a 2-year period during the breaching process. A new transmission line from Spokane to Tri-Cities would account for $100 to $150 million of the expense. The remainder of the spending is for projects in the downriver subregion. It is assumed that the impacts all occur in the downriver subregion. The annual spending of $88.50 to $135.50 million to modify power lines would result in $196.10 to $300.30 million in business sales, 1,643 to 2,516 jobs, and $61.90 to $94.70 million of personal income.

6.3.1.6 Transmission Line Operation and Maintenance

Spending to operate and maintain new electricity transmission lines of approximately $0.85 million is assumed to occur annually. It is assumed that the spending would occur somewhere in the lower Snake River region. The lower Snake River region electric utility multipliers are 1.9634, 0.00001052, and 0.4095 for business sales, employment, and personal income respectively. The $0.85 million spent to operate and maintain power lines would result in $1.67 million of business sales, eight jobs and $0.35 million of personal income.

6.3.2 Recreation

Fishing trips and recreation and tourism trips by non-residents create new spending flows in the region where the visit occurs. Sportfishing, recreation, and tourism by non-residents are, as a result, exports that stimulate the local economy. Changes in recreation projected by the DREW Recreation Workgroup (1999) would increase these types of exports in two ways. First, the total number of trips per year to the fishing and recreation sites would increase. Second, the share of trips made by non-residents would also increase.

Alternative 4, Dam Breaching, is expected to increase steelhead and salmon runs in all three subregions, and along the coastal areas of the Pacific Northwest (DREW Anadromous Workgroup, 1999). Breaching, however, reduces or eliminates some species of fish currently available on the four lower Snake River reservoirs and the allocation of salmon for sportfishing harvest, even after breaching, is very small. The number of fishing trips made to these areas is expected to increase in response to increased fishing opportunities. This increase would, however, be severely limited by the number of fish available for recreational harvest.

Alternative 4, Dam Breaching, would also return the lower Snake River to free flow, suitable for rafting, kayaking and other river-based activities. Current flat-water oriented recreation activities would no longer be possible. A contingent behavior survey conducted by the DREW Recreation Workgroup (1999) projected that the number of recreation trips to a free-flowing lower Snake River in the reservoir subregion would be greater than the number of trips that would be made to the reservoirs (see Section 3.2). The contingent behavior surveys measured consumer intentions to visit the sportfishing and river recreation sites with and without Alternative 4, Dam Breaching.

Changes in spending on sportfishing and other recreation trips with Alternative 4, Dam Breaching, are based on surveys of current sportfishing and other recreation visitation for the reservoir and upriver subregions, Corps visitation data, and the contingent behavior surveys (DREW Recreation Workgroup, 1999).

6.3.2.1 Sportfishing in the Upriver Subregion

Increases in sportfishing in central Idaho and northeast Oregon are projected under Alternative 4. These increases would generate additional business sales, employment, and personal income in the upriver subregion (Table 6-5). These impacts, based on the number of fish available for harvest, increase over time. Sportfishing projections made by the DREW Recreation Workgroup are based on preliminary PATH data extended by the DREW Anadromous Fish Workgroup (1999). Alternatives 2 and 3 would not create significant upriver fishing impacts.

Table 6-5. Annual Economic Effects of Fishing in the Upriver Subregion for Alternative 4, Dam Breaching (1998 dollars) 1/

Year	Increase in Business Sales, 1998 ($ Million per Year)	Increase in Jobs	Increase in Personal Income, ($ Million per Year)
0	6.15	92	1.73
5	4.40	66	1.24
10	28.74	432	8.10
15	20.98	312	5.85
20	24.57	369	6.92
25	25.70	386	7.24
30 to 100	26.74 to 28.43	402 to 427	7.56 to 8.01

1/ The increase in fishing trips is constrained by the supply of fish projected by PATH and the DREW Anadromous Fish Workgroup, 1999.

Source: DREW Recreation Workgroup, 1999

6.3.2.2 Sportfishing in the Reservoir Subregion

Increases in sportfishing in the reservoir subregion are projected under Alternative 4. The associated increases in business sales, employment, and personal income are presented in Table 6-6. These impacts, based on the number of fish available for harvest, increase over time. These impacts are based on numbers of fish projected by PATH and the DREW Anadromous Fish Workgroup (1999). Fishing trips are constrained below both the DREW Recreation Workgroup contingent behavior "low" and "medium" forecasts of fishing demand by the limited availability of fish

projected by PATH and the DREW Anadromous Fish Workgroup. Alternatives 2 and 3 would not create significant upriver fishing impacts.

Table 6-6. Annual Economic Effects of Fishing in the Reservoir Subregion for Alternative 4, Dam Breaching (1998 dollars) 1/

Year	Increase in Business Sales ($ Million per Year)	Increase in Jobs	Increase in Personal Income ($ Million per Year)
0	3.4	36	0.86
5	2.79	29	0.71
10	4.72	50	1.2
15	5.44	57	1.39
20	7.1	75	1.81
25	8.77	92	2.23
30 to 100	8.99 to 9.47	93 to 99	2.29 to 2.41

1/ Fishing trips are constrained below both the "middle" and "low" DREW Recreation Impact Workgroup (1999) contingent behavior forecasts of fishing demand due to the limited availability of fish projected by PATH and the DREW Anadromous Fish Workgroup (1999).

Source: DREW Recreation Impact Workgroup (1999).

6.3.2.3 Recreation and Tourism in the Reservoir Subregion

Increases in recreation and tourism are projected under Alternative 4, Dam Breaching. The associated increases in business sales, employment, and personal income are presented in Table 6-7. The impacts shown are based on the DREW Recreation Workgroup contingent behavior "middle level" forecast, which were not constrained by available recreation facilities and river congestion (see Section 3.2). Alternatives 2 and 3 would not affect existing and currently projected recreation and tourism in the reservoir subregion.

Table 6-7. Annual Economic Effects of River Recreation in the Reservoir Subregion Middle Forecast for Alternative 4, Dam Breaching (1998 dollars) 1/

Year	Increase in Business Sales ($ Million per Year)	Increase in Jobs	Increase in Personal Income 1998 ($ Million per Year)
0	35.95	456	9.65
5	49.84	631	13.37
10	73.14	927	19.63
20 to 100	77.28	980	20.74

1/ The "middle" forecast is based on the DREW Recreation Impact Workgroup (1999) contingent behavior survey for recreation visits with breaching.

Source: Based on data from the DREW Recreation Workgroup, 1999

6.3.3 Commercial and Ocean Recreational Fishing

Regional economic impacts associated with commercial and ocean recreational fishing were estimated by the DREW Anadromous Fish Workgroup using input-output models that translate direct fishing expenditures and hatchery costs into personal income. This analysis addressed

changes in the Pacific Northwest states, Alaska, and British Columbia. Representative budgets from the fish harvesting and processing sectors, as well as a price and cost structure for processing are used to estimate the changes.

The economic evaluation not only considered commercial harvesting and processing of wild and hatchery originating fish, but also sales of hatchery returns for egg, carcass, and food fish sales. The economic modeling provided per fish unit values for the various user groups and fisheries. Anadromous fish forecasts provided a simulation of where, how many, what species, and which user group (ocean and river commercial, treaty, hatchery surplus sales) is doing the harvests of stocks that will be affected by the hydrosystem actions. Total economic impacts values are then a function of distributed harvests and fish unit values.

Increases in commercial and ocean recreation harvest of anadromous fish would add $31.87 million in business sales, 249 jobs, and $10.6 million in personal income. Most of the regional economic impacts would be generated from the inriver commercial treaty fishery contributed from fall chinook.

6.3.4 Transportation

6.3.4.1 New Construction for Rail Transport

If dam breaching were to occur, a large portion of grain presently shipped via the lower Snake River would be diverted to rail. New railroad hopper cars costing $14.00 to $26.85 million would be required. For the purposes of analysis, it was assumed, that construction of these railcars would take place outside the Pacific Northwest region.

Increased grain shipments via rail would result in an increase of 8 to 12 unit-trains or 900 to 1,330 cars being delivered to tidewater terminals each month. Rail storage at tidewater terminals would be needed for 450 to 650 of these cars. Existing rail car storage would be inadequate to accommodate this increase. Construction of tidewater railroad track for car storage is projected to cost between $1.99 and $4.05 million. This construction, which would take place in Oregon, was modeled using the IMPLAN new road construction sector multipliers for Oregon. This sector includes other heavy construction, such as railroad construction. This construction spending would generate from $4.74 to $9.64 million in business sales, 41 to 81 jobs, and $1.21 to $2.46 million in personal income.

Upgrades to mainline track would be required. Construction spending associated with these upgrades is estimated to range from $14 to $24 million. Upgrades would also be required for short-line railroads. These costs are estimated to range from $33.9 to $47.8 million. This construction, which would take place in the lower Snake River region, was modeled using the IMPLAN new road construction sector multipliers for the lower Snake River study area. This new construction spending would generate from $86.73 to $122.29 million in business sales, 723 to 1,020 jobs, and $23.16 to $32.66 million in personal income. It is assumed that railroad track improvements would have to be completed rapidly (within a year) to meet the increased rail car traffic.

6.3.4.2 Impacts of New Construction for Road Transport

Dam breaching would also result in increased volumes of truck traffic on Washington highways. This increase in traffic would require one-time intersection and road improvements. Estimated

construction costs range from $84.10 to $100.70 million. This construction, which would take place in the lower Snake River region, was modeled using the IMPLAN new road construction sector multipliers for the lower Snake River study area. This new construction spending would generate from $215.16 to $257.63 million in business sales, 1,794 to 2,149 jobs, and $57.46 to $68.80 million in personal income. Road and intersection improvements would have to be completed rapidly (within a year) to accommodate the increased heavy truck traffic.

6.3.4.3 Impacts of New Construction for Transport-related Facilities

The projected shift of grain from the lower Snake River to rail would require country grain elevator upgrades with estimated construction costs of $14.00 to $16.90 million. Construction costs for river elevator upgrades are estimated to range from $58.7 to $335.4 million depending on the type of facility built. This construction, which would take place in the lower Snake River region, was modeled using the IMPLAN new industrial buildings sector multipliers for the lower Snake River study area. This new construction spending would generate from $202.95 to $983.48 million in business sales, 1,991 to 9,646 jobs, and $6.75 to $329.96 million in personal income. (Note: the most likely impacts were set at 1.2 times the average impacts for transport-related facilities by the DREW Transportation Workgroup, 1999.) Grain elevator improvements would have to be completed rapidly (within a year) to accommodate the increased use of rail and truck in place of barge transport.

6.3.4.4 Impacts of Dam Breaching on Industries Using or Replacing Barge Transport

The potential effects of increased transportation costs associated with dam breaching are complex. On the one hand, the trucking/warehousing sector could decline because current shipments of grains and other products to ports in Lewiston/Clarkston from locations in Idaho, Montana, and North Dakota would no longer take place. On the other hand, trucking to rail terminals and ports located near Tri-Cities might increase.

The effect on rail transport which is more labor-intensive than barge transportation, is also complicated. A shift of transport mode from barge to rail implies slightly increased transport employment in the upriver and reservoir subregions. This outcome is, however, based on the implicit assumption that demand for transportation would not be affected by increases in cost.

Increased transportation costs as a result of dam breaching could have a number of effects. First, a "substitution effect" can cause a search for alternate carriers or alternate routes to minimize the impact of increased transport costs. Lacking alternate carriers, routes for some products may shift away from the West Coast and the upriver subregion. Second, the "output effect" of increased transport costs can cause producers to reduce their outputs because they become less competitive on national and world markets when their cost of production increases. A third effect is the "stages of production" effect. Export of raw materials is promoted by low-cost transportation. Bulk materials are less likely to be shipped if the cost per ton is increased. The choice is either to stop producing the bulk materials, or increase the stages of production so that the materials shipped out have a higher value per ton. The latter option implies that more processed goods would be shipped out of the region and fewer bulk materials. Local value added (and employment) within the upriver subregion could rise if this were to take effect. Total quantity shipped might fall and yet the total

value shipped might rise if more processing of raw materials were conducted in the upriver subregion.

Given these possible long-run adjustments to increased transport costs, it is unclear how much transport volume might fall over time if barging were eliminated. No studies exist to project the possible changes in shipping volume. As a result, it is not possible to model the direct, indirect, and induced effects in the industries using the transport sector or in the transport sector itself. The price sensitivity of transport demand depends upon the impacts upon, and the unknown reactions by, the sectors that use these transport services.

6.3.4.5 Cruise Ship Effects of Alternative 4, Dam Breaching

Existing cruise ships would not be able to operate on a free-flowing Snake River. Based on contacts made with a sample of cruise ship companies, it appears that breaching the lower Snake River dams would terminate the cruise-ship industry in the Lewiston/Clarkston area and probably on the Columbia River with the exception of day-trips (DREW Transportation Workgroup, 1999). It is, however, likely that some of the cruise ship employment and retail sales to passengers would shift to the downriver subregion if the Snake River were unavailable with breaching.

Direct non-payroll purchases by the cruise ship sector in the upriver subregion are estimated at $2.64 million per year (DREW Transportation Workgroup, 1999). Cruise ship companies purchase engine fuel, jet boat services, laundry services, water supplies, and docking. The largest purchases are for prepaid jet boat tours and fuel, which account for about 46 and 45 percent of direct purchases. A reduction in direct purchases and payroll by cruise ship companies in the upriver subregion would result in a decrease of $7.96 million in annual business sales, 76 lost jobs, and $2.11 million lost personal income per year. The total impact estimate also includes the effects of direct cruise ship employment and payroll in the upriver subregion based on confidential reports (DREW Regional Workgroup, 1999).

About 21,315 passengers are estimated to travel to the upriver subregion by cruise ship (DREW Transportation Workgroup, 1999). Assuming that the average spending per passenger in Lewiston is $57, the annual loss of retail sales to cruise ship passengers in the upriver subregion would be about $1.21 million. The IMPLAN multipliers for retail trade apply on the sales margin, which is about 15 percent of actual retail sales. Lost retail sales would reduce total business sales by $0.43 million, employment by seven jobs, and personal income by $0.14 million in the upriver subregion.

Total impacts include the effects of lost sales to cruise ship companies, lost cruise ship payroll, and lost retail sales to passengers. Total direct, indirect, and induced losses in the upriver subregion are estimated at $8.39 million per year in business sales, 83 jobs, and $2.25 million per year in personal income.

6.3.5 Water Supply

6.3.5.1 Agricultural Pump Stations

Approximately 37,000 acres of cropland are presently irrigated from Ice Harbor Reservoir. The analysis conducted by the DREW Water Supply Workgroup (1999) (see Section 3.4) suggested that in the absence of Congressional appropriation, the costs to modify the existing pump system would be prohibitive based on the estimated value of the land. The estimated change in farmland value

would be in the reservoir subregion, but reduced farm spending would also occur in the downriver subregion, therefore, the lower Snake River study area multipliers were used.

The following is an attempt to display an array of scenarios of regional impacts. Assuming that the entire 37,000 acres were to go of business would result in an annual decrease in business sales of $232.26 million, a loss of 2,256 jobs, and an annual reduction in personal income of $79.19 million. About 21 percent of the irrigated land might support the development of alternative water supplies to replace the lost irrigation water. If fruit orchards and vineyard production continued on 7,735 of the 37,000 acres, the direct value of production lost would be $38.37 million. In this case, annual business sales would fall by $119.43 million, 901 jobs would be lost, and personal income would fall by $42.07 million per year.

6.3.5.2 Municipal and Industrial (M&I) Pump Station Modifications

There are eight existing municipal and industrial pump stations along the lower Snake River, all located on the Lower Granite Reservoir. Water withdrawn from these stations is used for municipal water system backup, golf course irrigation, industrial process water for paper production, concrete aggregate washing, and park irrigation. Under Alternative 4, Dam Breaching, the river elevation would be substantially lower and these pumping stations would require modification to maintain current water supplies (DREW Water Workgroup, 1999).

Modification of municipal and industrial pump stations was estimated to cost between $11.51 million and $55.20 million (DREW Water Supply Workgroup, 1999). This wide range of costs reflects uncertainty about required modifications to the Potlatch Corporation system (DREW Water Supply Workgroup, 1999). The impacts of construction associated with these modifications were estimated using the upriver subregion utility construction multiplier and assumed to be one-year impacts. This spending would result in an increase in business sales of $25.14 to $120.56 million, an increase of 292 to 1,397 jobs, and increases in personal income that would range from $7.73 to $37.10 million.

6.3.5.3 Construction Expenditures to Modify Private Wells

Approximately 209 functioning wells are presently located within one mile of the lower Snake River. About 95 of these wells are expected to require modification if dam breaching were to occur (DREW Water Supply Workgroup, 1999). Construction spending in the reservoir subregion to modify private wells was estimated at $56.45 million (DREW Water Supply Workgroup, 1999). About 22 percent of the wells were in the downriver subregion (Franklin County) and the rest were in the reservoir subregion. The impact of construction expenditures to modify private wells was estimated using the maintenance and repair not elsewhere classified sales multiplier. Well modification in the reservoir subregion would result in a $107.76 million increase in business sales, an increase of 916 jobs, and an increase in personal income of $29.52 million. Well modification in the downriver subregion would result in a $30.40 million increase in business sales, an increase of 259 jobs, and an increase in personal income of $8.33 million. These are assumed to be 1-year impacts.

6.3.6 Implementation Expenditure Effects

Implementation of the selected alternative would require modifications to the operation and physical structure of the four lower Snake River dams, hydroelectric plants, and reservoirs. Implementation activities proposed under each alternative include new construction spending and spending on mitigation.

The implementation effects of breaching the four dams are summarized in Tables 6-8 through 6-10. These effects were estimated based on information provided by the DREW Implementation Workgroup (1999). Direct, indirect, and induced effects are shown for business sales, employment, and personal income by alternative and over time.

6.3.7 Avoided Cost Expenditure Effects (Changes in Corps Operating Spending)

Alternatives 2 and 3 would result in relatively small modifications to Corps spending. Alternative 4, Dam Breaching, results in much reduced spending because of the shut down of electric generation operations, dam operations, and lock operations. Tables 6-11 through 6-13 summarize the effects for Alternatives 2 and 3. The effects of the reduced Corps operating costs under the Alternative 4, Dam Breaching, are presented in Table 6-14. Effects are shown for business sales, employment, and personal income over time. These effects would primarily occur in the lower Snake River study area.

Table 6-8. Short Term Economic Effects of Implementation of Business Sales (1998 dollars) ($ Million per Year)1/

Year	Alternative 2 - Maximum Transport of Juvenile Salmon	Alternative 3 – Major System Improvements	Alternative 4 - Dam Breaching
2001	(1.89)	(1.48)	11.03
2002	(7.36)	(4.39)	(8.92)
2003	(4.63) or (6.94)	11.72 or 9.41	22.95 or 20.63
2004	1.64 or (5.15)	33.05 or 26.26	111.28 or 104.48
2005	0	28.41	202.27
2006	0	14.96	198.54
2007	0	0	169.37
2008	0	0	47.02
2009	0	0	24.71

1/ Two sets of baseline data definitions were used for the years 2003 and 2004 by the DREW Implementation Workgroup (1999).

Table 6-9. Short Term Economic Effects of Implementation on Employment (Jobs)[1/]

Year	Alternative 2 - Maximum Transport of Juvenile Salmon	Alternative 3 - Major System Improvements	Alternative 4 - Dam Breaching
2001	(28)	(22)	164
2002	(110)	(67)	(132)
2003	69 or (103)	176 or 140	343 or 308
2004	24 or (77)	495 or 392	1,664 or 1,564
2005	0	426	3,025
2006	0	223	2,970
2007	0	0	2,532
2008	0	0	704
2009	0	0	369

1/ Two sets of baseline data definitions were used for the years 2003 and 2004 by the DREW Implementation Workgroup (1999).

Table 6-10. Short Term Economic Effects of Implementation on Personal Income (1998 dollars) ($ Million)[1/]

Year	Alternative 2 - Maximum Transport of Juvenile Salmon	Alternative 3 - Major System Improvements	Alternative 4 - Dam Breaching
2001	(0.76)	(0.6)	4.52
2002	(3.01)	(1.8)	(3.66)
2003	(1.89) or (2.84)	4.79 or 3.85	9.41 or 8.46
2004	0.67 or (2.11)	13.51 or 10.74	45.62 or 42.84
2005	0	11.62	82.93
2006	0	6.12	81.4
2007	0	0	69.44
2008	0	0	19.28
2009	0	0	10.13

1/ Two sets of baseline data definitions were used for the years 2003 and 2004 by the DREW Implementation Workgroup (1999).

Table 6-11. Annual Economic Effects of Avoided Costs on Business Sales (1998 dollars) ($ Million), Alternatives 2 and 3

Year	Alternative 2 - Maximum Transport of Juvenile Salmon	Alternative 3 - Major System Improvements
2001 to 2026	(4.09)	2.18
2027 to 2100	0	1.26

Table 6-12. Annual Economic Effects of Avoided Costs on Employment (Jobs), Alternatives 2 and 3

Year	Alternative 2 - Maximum Transport of Juvenile Salmon	Alternative 3 - Major System Improvements
2001 to 2026	(83)	44
2027 to 2100	0	25

Table 6-13. Annual Economic Effects of Avoided Costs on Personal Income (1998 dollars) ($ Million), Alternatives 2 and 3

Year	Alternative 2 - Maximum Transport of Juvenile Salmon	Alternative 3 - Major System Improvements
2001 to 2026	(2.36)	1.26
2027 to 2100	0	0.73

Table 6-14. Annual Economic Effects of Avoided Costs on Business Sales, Jobs and Personal Income for Alternative 4, Dam Breaching (1998 dollars)

Year	Change in Business Sales, 1998 ($ Million per Year)	Change in Employment (Jobs)	Change in Personal Income, 1998 ($ Million per Year)
2001	(6.67)	(135)	(3.85)
2002	(6.67)	(135)	(3.85)
2003	(6.67)	(135)	(3.85)
2004	(7.08)	(143)	(4.09)
2005	(6.05)	(122)	(3.5)
2006	(27.97)	(565)	(16.16)
2007 to 2100	(59.04) to (81.72)	(1,193) to (1,651)	(34.11) to (47.22)

6.4 Summary of Effects

6.4.1 Effects at the State Level

Several impact categories occur either throughout the Pacific Northwest, throughout a State, or in an area of a State outside the Subregions. In addition, impacts associated with changes in commercial and ocean recreational fishing occur in the Pacific Northwest states, Alaska, and British Columbia, Canada.

Increased electric power bills would cause business sales, employment, and personal income to fall in the States of Washington, Oregon, Idaho, and Montana, as shown in Table 6-15.

Table 6-15. Annual Impacts of Increased Electric Power Bills, by State (1998 dollars)[1/]

	Washington	Oregon	Idaho	Montana
Business Sales ($ million per year)	(205.69)	(128.70)	(54.81)	(10.37)
Employment (jobs)	(1,136)	(810)	(366)	(70)
Personal Income ($ million per year)	(119.82)	(73.22)	(32.83)	(6.20)

1/ This table excludes the impacts of plant shut down or business failures caused by increased electric bills.

Three combined cycle electric power plants would be built in the Puget Sound region of Washington. Construction of each of these plants would occur in different years and would create about $332.40 million in business sales, 2,786 jobs, and $104.80 million in personal income in the State of Washington over three one year periods.

Operation and maintenance of the three combined cycle power plants would add $140.70 million in business sales, 876 jobs, and $23.58 million in personal income to Puget Sound region of the Washington State economy.

Construction of tidewater rail car storage in Oregon is projected to cost about $3.02 million and create $7.19 million in sales, 63 jobs, and $1.84 million in personal income. These construction impacts would only last one year.

Increases in commercial and ocean recreation harvest of anadromous fish in the Pacific Northwest states of Washington and Oregon, Alaska, and British Columbia, Canada would add $31.87 million in business sales, 249 jobs, and $10.6 million in personal income.

Effects by subregion are discussed for business sales, employment, and income in the following three sections. The effects summarized in these sections were modeled using the upriver, reservoir, and downriver subregion and total lower Snake River study area input-output models. These models identify localized impacts associated with the proposed alternatives.

6.4.2 Business Sales

6.4.2.1 Alternative 1, Existing Conditions

Alternative 1, Existing Conditions, represents the baseline for this analysis. Current business sales estimated by IMPLAN are $34,427.47 million for the lower Snake River study area. Subregion totals range from $6,744.85 million for the reservoir subregion to $19,717.96 million for the downriver subregion.

6.4.2.2 Alternative 2, Maximum Transport of Juvenile Salmon

Changes to business sales under this alternative would be relatively minor and limited to the implementation and avoided costs categories. Business sales associated with implementing this alternative from 2001 to 2004 are projected to range from an annual loss of $5.15 million to an annual gain of $1.64 million compared to Alternative 1, Existing Conditions (Table 6-8). Changes in the Corps' operating expenditures (avoided costs) would result in an annual reduction of $4.09 million in business sales from 2001 to 2026 (Table 6-11).

6.4.2.3 Alternative 3, Major System Improvements

Employment change under this alternative would also be relatively minor and limited to jobs associated with implementation and avoided costs. Business sales associated with implementing this alternative from 2001 to 2006 are projected to range from an annual loss of $4.39 to an annual gain of $33.05 million compared to Alternative 1, Existing Conditions (Table 6-8). Changes in the Corps' operating expenditures (avoided costs) would result in increased annual business sales of $2.18 million from 2001 to 2026 and $1.26 million from 2027 to 2100 (Table 6-11).

6.4.2.4 Alternative 4, Dam Breaching

Changes in business sales associated with this alternative can be divided into short-term and long-term effects. Short-term effects, mainly associated with construction activities, would be temporary and last less than 10 years (Table 6-16). Long-term effects would be permanent (Table 6-17). These impacts caused by changes in spending include indirect and induced business sales, therefore,

changes in business sales are distributed throughout the regional economy and not only concentrated in the sector where the initial change in spending occurs.

Construction activities resulting directly and indirectly from breaching the four lower Snake River dams would result in increased business sales of $2,263 million in the lower Snake River study area over a 10-year period (Table 6-16). The exact total would fluctuate from year to year. Major construction projects would include replacement power facilities ($913 million) and new grain elevators ($711.86 million).

In the long-run, annual business sales in the lower Snake River study area would increase by $216 million (Table 6-17). This increase would mainly be associated with the operation of replacement power facilities and recreation activities. The lower Snake River study area would, however, lose annual business sales of $249.66 million. The lost business sales would be mainly associated with Corps' operations and farmland irrigated from Ice Harbor Reservoir. This estimated long-term net change in annual business sales (-$33.65 million) represents less than 1 percent of current business sales in the lower Snake River study area.

Table 6-16. Annual Short-Term Business Sales Effects (1998 dollars) ($ Million) [1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
Total Business Sales[3/]	7,964.66	6,744.85	19,717.96	34,427.47
Power Plant Construction[4/]	0.00	0.00	664.80	664.80
Transmission Line Construction	0.00	0.00	248.20	248.20
Rail Construction[5/]				104.51
Road Construction[5/]				236.40
Transportation Facilities Construction[5/]				711.86
Well Modification	0.00	107.76	30.40	138.16
Pump Modification	72.85	0.00	0.00	72.85
Implementation	17.29	34.59	34.59	86.47
Total Change[6/]	90.14	142.35	977.99	2,263.25
Change as % of Existing Business Sales	1.13	2.11	4.96	6.57

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years. A number of the impacts have a wide range of variation depending on the magnitude of construction and the length of the time period.

2/ The three subregions comprise the lower Snake River study area. Changes in business sales in this area include the sum of changes in business sales across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.

3/ Existing business sales estimates were obtained from IMPLAN.

4/ The DREW Hydropower Impact Team (DREW Hydropower Impact Team) assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but DREW Hydropower Impact Team assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate $332.40 million in short-term business sales. The estimates shown in this table are the maximum increase in business sales that would occur in any one year—$664.80 million in the downriver subregion, where two plants would be constructed simultaneously.

5/ These effects would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

6/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

The preceding estimates are based on midpoints when only lower and upper bounds were available from the other DREW workgroups. Averages are shown when the effects vary by year over a number of years. The average for the implementation category was calculated over a 9-year period. The averages for the recreation and avoided costs categories were calculated over a 100-year period.

Table 6-17. Annual Long-Term Business Sales Effects (1998 dollars) ($ Million) 1/

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area 2/
Total Business Sales 3/	7,964.66	6,744.85	19,717.96	34,427.47
O&M Spending on Replacement Power Plants & New Transmission Lines	0.00	0.00	142.37	142.37
Recreation (inc. Angling) 4/	24.90	8.07		73.64
Total Long-Term Increase in Business Sales 5/	**24.90**	**8.07**	**142.37**	**216.01**
Reduction in Irrigated Lands	0.00	(123.09)	(52.76)	(175.85)
Avoided Costs (Reductions in Corps' Spending)	(6.54)	(52.34)	(6.54)	(65.42)
Reduced Cruise Ship Operations	(8.39)	0.00	0.00	(8.39)
Total Long-Term Loss in Business Sales	**(14.93)**	**(175.43)**	**(59.30)**	**(249.66)**
Net Long-Term Change in Business Sales 5/	(14.93)	(175.43)	83.07	(33.65)
Net Change as % of Existing Business Sales	0.19	(2.60)	0.42	(0.10)

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.

2/ The three subregions comprise the lower Snake River study area. Change in business sales in this area is the sum of business sales changes across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.

3/ Existing business sales estimates were obtained from IMPLAN.

4/ These effects would occur in the lower Snake River study area, but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

6.4.3 Employment

6.4.3.1 Alternative 1, Existing Conditions

Alternative 1, Existing Conditions, represents the baseline for this analysis. Total full-time and part-time employment in the 25-county lower Snake River study area was 318,740 in 1995.

6.4.3.2 Alternative 2, Maximum Transport of Juvenile Salmon

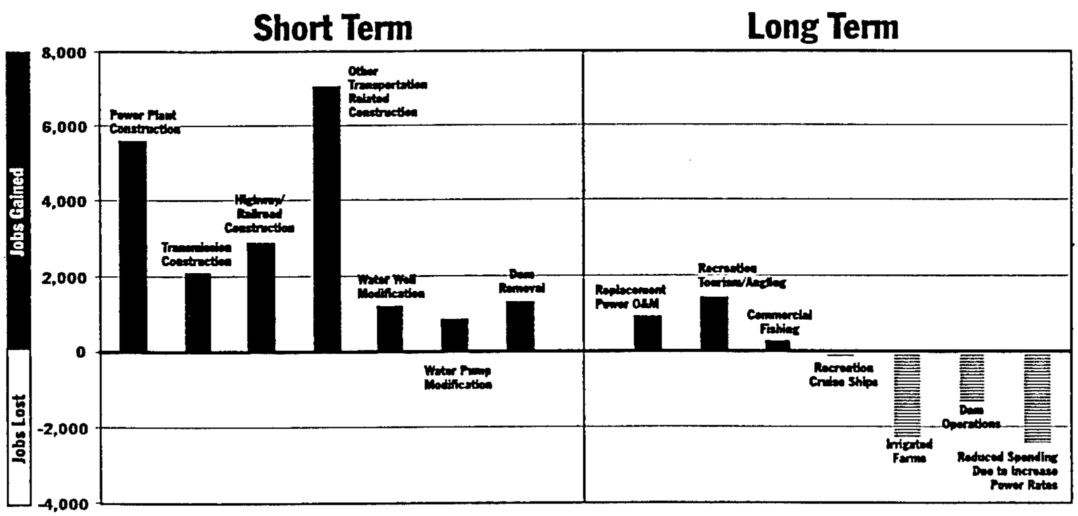
Employment change under this alternative would be relatively minor and limited to jobs associated with implementation and avoided costs. Employment associated with implementing this alternative from 2001 to 2004 is projected to range from a loss of 110 jobs to a gain of 69 jobs compared to Alternative 1, Existing Conditions (Table 6-9). Changes in the Corps' operating expenditures (avoided costs) would result in 83 less jobs from 2001 to 2026 than Alternative 1, Existing Conditions (Table 6-12).

6.4.3.3 Alternative 3, Major System Improvements

Employment change under this alternative would also be relatively minor and limited to jobs associated with implementation and avoided costs. Employment associated with implementing this alternative from 2001 to 2006 is projected to range from a loss of 67 jobs to a gain of 495 jobs compared to Alternative 1, Existing Conditions (Table 6-9). Changes in the Corps' operating expenditures (avoided costs) would result in 44 more jobs than Alternative 1, Existing Conditions, from 2001 to 2026 and 25 more jobs from 2027 to 2100 (Table 6-12).

6.4.3.4 Alternative 4, Dam Breaching

Employment effects associated with this alternative can be divided into short-term and long-term effects. Short-term effects, mainly associated with construction activities, would be temporary and last less than 10 years. Long-term effects would be permanent. These impacts caused by changes in spending include indirect and induced jobs. Therefore, jobs gained and lost are distributed throughout the regional economy and not only concentrated in the sector where the initial change in spending occurs. Projected short- and long-term effects are summarized graphically in Figure 6-1.



Notes

1. Short-term impacts would be temporary and last less than 10 years.
2. Long-term impacts would be permanent.
3. Effects are presented net of the base case (Alternative 1, Existing Conditions).
4. Short-term and long-term employment estimates for each resource area range from low to high and vary from year to year. These point estimates are either average, mid-point numbers, or "most likely" estimates provided by DREW workgroup leaders.
5. Increased electricity rates and transportation costs may cause affected firms or plants to reduce output and employment or possibly close or relocate to another region. Potentially-affected industries include aluminum manufacturing, paper manufacturing, and grain farms. Substantial proprietary information would be required to predict how individual firms would react to cost increases. As a result, possible job losses in these sectors are unknown.

Figure 6-1. Short- and Long-Term Employment Change

Short-term Employment Effects

Construction activities resulting directly and indirectly from breaching the four lower Snake River dams would result in a total of about 20,790 temporary jobs being generated in the lower Snake River study area over a 10-year period (Table 6-18). The exact number of jobs would fluctuate from year-to-year. This activity would generate a temporary increase in personal income of about $677 million (see Section 6.4.4) or an average income of $32,548 per job ($676.7 million in personal income/20,790 jobs). Major construction projects would include replacement power facilities (5,572 jobs) and new grain elevators (6,982 jobs).

Table 6-18. Short-Term Employment Effects (Jobs)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
1995 Employment	75,081	92,535	151,124	318,740
Power Plant Construction[3/]	0	0	5,572	5,572
Transmission Line Construction	0	0	2,080	2,080
Rail Construction[4/]				872
Road Construction[4/]				1,972
Facilities Construction[4/]				6,982
Well Modification	0	916	259	1,175
Pump Modification	844	0	0	844
Implementation	259	517	517	1,293
Total Change[5/]	**1,103**	**1,433**	**8,428**	**20,790**
Change as % of 1995 Employment	1.47	1.55	5.58	6.52

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years. A number of the impacts have a wide range of variation depending on the magnitude of construction and the length of the time period.

2/ The three subregions comprise the lower Snake River study area. Employment change in this area includes the sum of employment change across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.

3/ The DREW Hydropower Impact Team (DREW Hydropower Impact Team) assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but DREW Hydropower Impact Team assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate 2,786 short-term jobs. The estimates shown in this table are the maximum number of these jobs that would be generated in any one year—5,572 in the downriver subregion, where two plants would be constructed simultaneously.

4/ These effects would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

Long-term Employment Effects

Lower Snake River Study Area

In the long run, the lower Snake River study area would gain 2,277 jobs with an average income of $23,144 ($52.7 million in personal income/2,277 jobs) (Table 6-19). These jobs would mainly be associated with the operation of replacement power facilities and recreation activities. The lower

Snake River study area would, however, lose 2,988 jobs with an average personal income of $33,066 ($98.8 million in personal income/2,988 jobs). The lost jobs would be mainly associated with Corps' operations and farmland irrigated from Ice Harbor Reservoir. The average annual income in the lower Snake River study area in 1995 was $32,088. This estimated net change in long-term jobs (-711 jobs) represents less than 1 percent of 1995 employment in the lower Snake River study area.

Table 6-19. Long-Term Employment Effects (Jobs) [1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2]
1995 Employment	75,081	92,535	151,124	318,740
O&M Spending on Replacement Power Plants & New Transmission Lines	0	0	884	884
Recreation (inc. Angling) [3/]				1,393
Total Long-Term Employment Gain[4/]	**0**	**0**	**884**	**2,277**
Reduction in Irrigated Lands	0	(1,105)	(474)	(1,579)
Avoided Costs (Reductions in Corps' Spending)	(133)	(1,060)	(133)	(1,326)
Reduced Cruise Ship Operations	(83)	0	0	(83)
Total Long-Term Employment Loss	**(216)**	**(2,165)**	**(607)**	**(2,988)**
Net Long-Term Employment Change[4/]	(216)	(2,165)	277	(711)
Net Change as a % of 1995 Employment	(0.29)	(2.34)	0.18	(0.22)

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.

2/ The three subregions comprise the lower Snake River study area. Employment change in this area includes the sum of employment change across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.

3/ These effects would occur in the lower Snake River study area. but it is not known how they would be distributed among the subregions.

4/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the Study Area impacts were not distributed by subregion.

The average personal income figures presented above for the jobs gained and lost were derived by dividing the projected changes in total personal income (see Section 6.4.4) by the number of jobs. These projected changes in income, like the projected changes in employment, include direct, indirect, and induced jobs. Therefore, the average personal income projections calculated by dividing change in total personal income by change in jobs represent changes throughout the regional economy not just in the directly affected sectors. It is also important to recognize that personal income, as used in this analysis, consists of wages, salaries, social insurance, and profit received by individuals. As a result, the personal income figure calculated by dividing changes in total personal income by changes in jobs is not directly equivalent to the average wage or salary that would be received by the workers doing those jobs.

It may also be noted that the projected job totals include both full-time and part-time employment. The standard conversion factor from full-time and part-time employment totals to full-time equivalents (FTE) is 0.88. In other words, the projected job losses and gains in the lower Snake River study area should be multiplied by 0.88 to obtain an indication of the number of full-time jobs

these totals represent. These conversion factors vary from sector to sector. The FTEs for the retail and services sectors, for example, are 0.81 and 0.87, respectively. The FTEs for the civilian and Federal government and manufacturing sectors are both 0.97.

The regional economic analysis prepared for this study developed estimates for each year of the 100-year study period. High, medium, and low estimates were developed for each year. The data presented in Tables 6-18 and 6-19 and summarized graphically in Figure 6-1 are point estimates based on mid-point numbers or "most likely" estimates provided by the DREW workgroups. Averages are shown when effects vary by year over a number of years. These numbers indicate the type and magnitude of annual employment changes that could occur. Another way to view this change is to view the net annual change in these mid-point or "most likely" estimates (Figure 6-2). Figure 6-2 includes regional impacts modeled for the lower Snake River study area and associated subregions and all state-wide impacts, including those associated with increased anadromous fish harvest. This figure indicates that despite the initial short-term construction boom, the long-term impact of breaching the four lower Snake River dams would be negative. It is important to recognize that there is considerable uncertainty surrounding long-term projections. Also, this presentation combines job change in the lower Snake River study area with job changes that would be spread over one or more states.

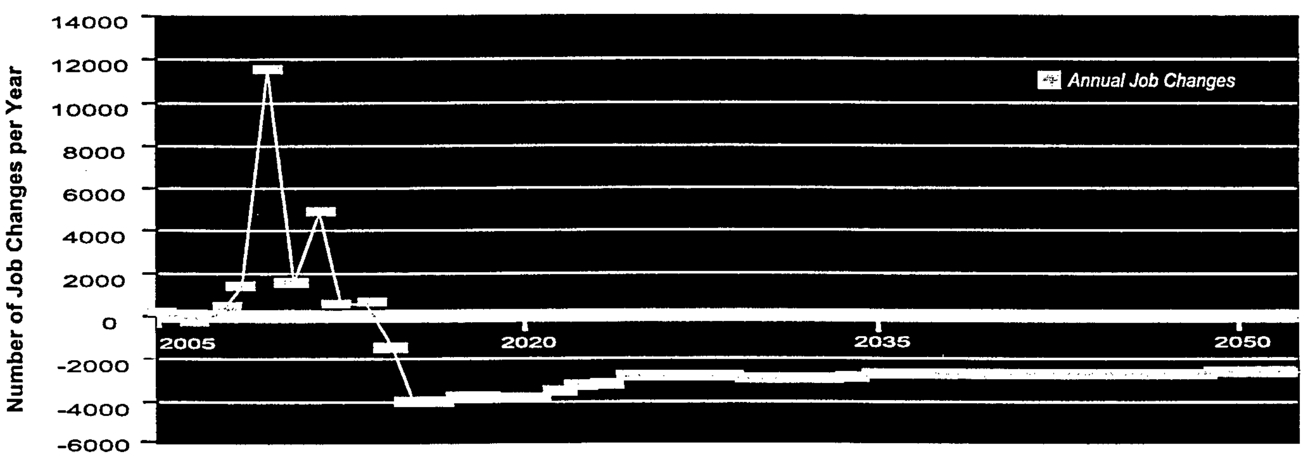


Figure 6-2. Net Annual Employment Change (2005-2055)

A third way to view these projected changes in long-term employment is presented in Section 7.1, Social Analysis. This analysis takes the net forecast developed for project year 20 and presents the range—low, medium, high—of projected impacts for that year and compares them to regional employment. This provides a different perspective to the estimates presented in this section which, as noted, are point estimates based on mid-point numbers or "most likely" estimates.

6.4.4 Income

6.4.4.1 Alternative 1, Existing Conditions

Alternative 1, Existing Conditions, is the baseline for this analysis. Total personal income in the 25-county lower Snake River study area was $10,822.81 million in 1995.

6.4.4.2 Alternative 2, Maximum Transport of Juvenile Salmon

Changes in personal income under this alternative would be associated with implementation and avoided costs. Changes in income associated with implementing this alternative from 2001 to 2004 are projected to range from a loss of $3.01 million to a gain of $0.67 million compared to Alternative 1, Existing Conditions (Table 6-10). Changes in the Corps' operating expenditures (avoided costs) would result in a relative loss of $2.36 million from 2001 to 2026 (Table 6-13).

6.4.4.3 Alternative 3, Major System Improvements

Changes in personal income under this alternative would also be associated with implementation and avoided costs. Changes in income associated with implementing this alternative from 2001 to 2006 are projected to range from a loss of $1.8 million to a gain of $13.51 million compared to Alternative 1, Existing Conditions (Table 6-10). Changes in the Corps' operating expenditures (avoided costs) would result in a gain of $1.26 million in personal income over Alternative 1, Existing Conditions, from 2001 to 2026 and $0.73 million from 2027 to 2100 (Table 6-13).

6.4.4.4 Alternative 4, Dam Breaching

Changes in personal income mirror the changes in jobs discussed in the preceding section. Personal income effects associated with this alternative can be divided into short-term and long-term effects. Short-term effects, mainly associated with construction activities, would be temporary and last less than 10 years. Long-term effects would be permanent. These impacts are summarized by subregion and state in Tables 6-20 and 6-21. These effects are caused by changes in spending patterns include indirect and induced jobs. Therefore, associated changes in income are distributed throughout the regional economy and not only concentrated in the sector where the initial change in spending occurs.

Net changes in short-term and long-term personal income are presented by subregion in Tables 6-20 and 6-21, respectively. Short-term increases in personal income in the lower Snake River study area would be about $676.7 million spread over 10 years. In the long run, total personal income in would increase by $52.7 million. This increase in income would mainly be associated with the operation of replacement power facilities and recreation activities. The lower Snake River study area would, however, experience a decrease in personal income of about $98.8 million. This lost income would be mainly associated with Corps' operations and farmland irrigated from Ice Harbor Reservoir. This estimated net change in long-term income (-$46.1 million) represents about 0.43 percent of total personal income in the lower Snake River study area in 1995.

Table 6-20. Short-Term Income Effects (1998 dollars) ($ million per year) [1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area [2/]
1995 Total Income	2,215	3,071	5,440	10,725
Power Plant Construction [3/]	0.0	0.0	209.6	209.6
Transmission Line Construction	0.0	0.0	78.3	78.3
Rail Construction [4/]				27.9
Road Construction [4/]				63.1
Facilities Construction [4/]				202.0
Tidewater Railcar Storage Construction				
Well Modification	0.0	29.5	8.3	37.9
Pump Modification	22.4	0.0	0.0	22.4
Implementation	7.1	14.2	14.2	35.5
Total Change [5/]	**29.5**	**43.7**	**310.4**	**676.7**
Change as % of 1995 Income	1.33	1.42	5.7	6.3

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years. A number of the impacts have a wide range of variation depending on the magnitude of construction and the length of the time period.

2/ The three subregions comprise the lower Snake River study area. The change in personal income in this area includes the sum of income change across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.

3/ The DREW Hydropower Impact Team (DREW Hydropower Impact Team) assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but DREW Hydropower Impact Team assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate 2,786 short-term jobs. The estimates shown in this table are the maximum number of these jobs that would be generated in any one year—5,572 in the downriver subregion, where two plants would be constructed simultaneously, and 2,786 jobs in the Puget Sound region, where the projected replacement plants would likely be constructed at different times.

4/ These effects would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

Table 6-21. Long-Term Income Effects ($ million)[1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
1995 Income	2,215	3,071	5,440	10,725
O&M Spending on Replacement Power Plants & New Transmission Lines	0.0	0.0	23.6	23.6
Increased Recreation (inc. Angling)[3/]				29.1
Total Long-Term Increase in Income[4/]	**0.0**	**0.0**	**23.6**	**52.7**
Reduction in Irrigated Lands	0.0	(41.1)	(17.6)	(58.6)
Avoided Costs (Reductions in Corps' Spending)	(3.8)	(30.3)	(3.8)	(37.9)
Reduced Cruise Ship Operations	(2.3)	0.0	0.0	(2.3)
Total Long-Term Loss of Income	**(6.0)**	**(71.4)**	**(21.4)**	**(98.8)**
Net Long-Term Change in Income[4/]	(6.0)	(71.4)	2.2	(46.1)
Net Change as a % of 1995 Income	(0.27)	(2.32)	0.05	(0.43)

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.

2/ The three subregions comprise the lower Snake River study area. Change in personal income in this area is the sum of income change across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.

3/ These effects would occur in the lower Snake River study area, but it is not known how they would be distributed among the subregions.

4/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River study area figure because some of the projected Study Area impacts were not distributed by subregion.

6.5 Unresolved Issues

The regional economic analysis depends upon information from the DREW study teams as the basis for estimating economic impacts. Thus, most of the unresolved issues listed by the other DREW study teams also limit the regional economic analysis.

In addition, insufficient information was available to model the potential impacts that the Alternative 4, Dam Breaching, could have on a number of regional industries. Increases in costs for electric power and transportation, decreases in the availability of irrigated farm output, and removal of the reservoirs and locks could cause significant cost increases for energy and transport intensive industries or in industries requiring reservoirs or inputs from agriculture. In some cases, it is possible that these cost increases could be large enough to cause affected plants or firms to close down or relocate to another region. Substantial proprietary information about each firm or plant, such as the cost and profit structure, would be required to allow prediction of those businesses that would close or relocate. It would also be necessary to forecast market prices for the potentially affected products into the future. These types of information are not publicly available and, therefore, it was not possible to identify those firms or plants that would be likely to close or relocate if dam breaching were to occur.

6.5.1 Potentially Affected Businesses

This section provides a qualitative discussion of those industries with businesses that might face increased costs and therefore respond by passing these costs on to consumers, restructuring, relocating, or closing if dam breaching were to occur. These industries include: primary aluminum manufacturing (electricity-intensive), paper manufacturing (transport-intensive), grain production (transport-intensive), food processing (dependent on fruit and vegetable inputs from irrigated agriculture), and water transport services (barge marine cargo, cruise ships, and marinas, requiring reservoirs and locks). The geographic extents of these potential impacts vary by industry. Potential increases in electricity rates associated with Alternative 4, Dam Breaching, would likely cause power costs to rise throughout the Pacific Northwest and could potentially affect primary aluminum manufacturers located throughout Washington, Oregon, and Idaho. Impacts associated with the other four potentially affected industries would likely be more localized. Potentially affected food processing firms are those located in the downriver and reservoir subregions. The portion of the paper manufacturing sector that has the most potential to be affected is concentrated in the upriver subregion. Grain farms located in the upriver subregion and the eastern part of the reservoir subregion would be most likely affected by breaching. Water transport firms that could potentially be affected by the dam breaching alternative are mainly concentrated in the upriver subregion.

Table 6-22 presents the estimated direct subregion and state employment in these sectors. This table identifies total direct employment in each sector in the subregions and region where unmeasured effects may occur. It also identifies total employment in each sector for the lower Snake River study area and the states of Washington, Oregon, and Idaho and the shares of this employment that are at risk in each sector.

The potentially affected jobs presented in Table 6-22 represent the maximum number of direct jobs that could be affected by sector and subregion (or states in the case of primary aluminum manufacturing). The extent of possible effects on these industries are unknown at this time. It should also be noted, however, that these are just direct jobs and do not include the multiplier effect that would occur with business closure. If, for example, a primary aluminum manufacturing plant with 580 employees in the downriver subregion shut down, the resulting multiplier effect throughout the local economy would result in a loss of 820 jobs. This would result in a total job loss of 1,400.

Possible effects on the food processing and paper manufacturing sectors are discussed further in the following sections.

Table 6-22. Estimated Direct Jobs in Potentially-Affected Industries by Subregion

Geographic Area	Primary Aluminum Mfg.	Food Processing (can/freeze)	Paper Mfg.	Grain Farms	Water Transport
Potentially Affected Jobs					
Upriver Subregion	0	0	1,778	1,646	134
Reservoir Subregion	0	1,917	0	3,488	0
Downriver Subregion	1,159	5,388	0	0	0
Lower Snake River Study Area Total	1,159	7,305	1,778	5,134	134
Pacific Northwest Total	6,260	7,305	1,778	5,134	134
Total Employment by Sector in the:					
Lower Snake River Study Area	1,159	7,305	2,423	11,314	185
Washington	5,300	21,705	11,579	10,893	9,495
Oregon	930	13,265	5,234	7,828	2,195
Idaho	30	9,275	1,780	8,668	300
Combined State Total	6,260	44,245	18,593	27,389	11,990
Potentially Affected Jobs as % of Total Jobs by Sector in the:					
Lower Snake River Study Area	100.0	100.0	73.4	45.4	72.4
Combined State Total	100.0	16.5	9.6	18.7	1.1

Source: Data compiled from IMPLAN

Food Processing

The potential loss of 37,000 acres of agricultural land presently irrigated from Ice Harbor Reservoir could affect food processing businesses that purchase the agricultural products presently grown on this land. Preliminary estimates of employment in the food processing industry that might potentially use products from the affected irrigated lands are approximately 5,000 to 6,500 full-time and part-time jobs. Estimates from IMPLAN indicate that direct employment in the food processing sector is approximately 7,305 full-time and part-time jobs in the reservoir and downriver subregions (Table 6-22).

The mix of crops presently grown on the 37,000 acres presently irrigated from Ice Harbor Reservoir was identified in a farm survey conducted by the DREW Water Supply Workgroup during 1997 and 1998 (see Section 3.4). The respective acreages identified during this survey were compared to the acreage in the states of Washington and Oregon that was dedicated to these same crops and also to the acreage dedicated to these crops in the counties surrounding the Tri Cities (Table 6-23). The potentially-affected 37,000 acres represents 1 percent of total irrigated agricultural lands in Washington and Oregon and 4 percent of irrigated lands in Walla Walla, Benton, Franklin, Yakima, Umatilla, and Morrow counties. The Ice Harbor irrigated acreages are presently dedicated to potatoes, orchards (apples, cherries, vineyards, etc.), and represent 8, 6, and 7 percent respectively of the acreage dedicated to these crops in the surrounding six-county area (Table 6-23). This comparison suggests that the crops grown on the 37,000 acres comprise a relatively small share of regional and state-wide production of these crops.

Table 6-23. Ice Harbor Irrigated Acres as a Percent of State and Surrounding County Totals

Irrigated Crop	Total Ice Harbor Irrigated Acreage	States of WA and OR Irrigated Acreage (1997)	Total Irrigated Acreage in Surrounding Counties[2]	Ice Harbor acreage as a % of OR and WA	Ice Harbor Acreage as a % of Surrounding Counties[2]
Potatoes	5,513	146,932	71,213	4%	8%
Wheat	3,515	401,363	115,123	1%	3%
Orchards	10,508	390,240	176,970	3%	6%
Vegetables	8,103	317,197	109,162	3%	7%
Total Harvested Irrigated Acres[1/]	37,000	3,051,054	933,447	1%	4%

1/ "Total Harvested Acres" figures from Ice Harbor do not equal totals of other lines because the Corps' survey was unable to identify the use of all the irrigated lands. In addition, 8,500 of the 37,000 acres are dedicated to hybrid poplar plantations.

2/ The surrounding counties are those contiguous to the hub of the Tri-Cities. Walla Walla, Franklin, Benton, Yakima, Umatilla and Morrow Counties were included in this supply region.

Industry representatives contacted as part of this study indicated that there are dynamic linkages between the food production and food processing sectors. Different businesses would be affected differently depending on the nature of these linkages. These relationships are complex and cannot be fully evaluated in the absence of an industry-specific study. The industry representatives contacted are not necessarily representative of the entire industry and information for the largest food processors in the region was not available. Therefore, while it is possible to identify a possible range of impacts, this qualitative assessment should be considered preliminary.

Contacts made with local food processors indicated that not all processors purchase products from Ice Harbor growers. Products that were purchased by food processors included wine grapes, asparagus, potatoes, corn, and apples. For those contacted firms that do purchase products from the Ice Harbor-irrigated lands, purchases ranged from 1 percent to 40 percent of their supply. One orchardist on Ice Harbor would not only lose water for a part of the farm but also the ability to pack 100 percent of these products on site. Processors were asked to indicate the significance of the loss of this supply to their operations. Responses ranged from insignificant to devastating.

Potential effects to processors may vary by crop type. Some processors suggested that the impacts associated with perennial crops, such as asparagus, which takes more than one year to establish, would be more significant. One processor indicated that the acres irrigated from Ice Harbor Reservoir produce high-quality products. Loss of this supply would affect the high-quality product lines even though it represents a relatively small portion of total supply. Another processor suggested that the loss of this supply might increase competition for remaining supplies, which would be more harmful for some firms than others. Finally, one processor noted that while firms would be unlikely to shut down, they would face supply problems and increased costs.

In addition to short-term effects on supply, increased competition for remaining raw materials, and associated increases in prices, industry representatives indicated that this loss of supply might have long-term detrimental effects on the food processing industry if alternate supplies are not

developed. Less certainty that the region could meet food processors demands for raw materials may represent a set-back for the industry, making it a higher investment risk and possibly slowing investment-dependent technological growth within the industry.

While this assessment is preliminary, it suggests that dam breaching may be unlikely to cause immediate significant job loss among the workers presently employed in the food processing sector in the reservoir and downriver subregions.

Forest Products

Increased transportation and other costs associated with dam breaching could affect the forest products industry in north-central Idaho. Detailed industry studies would be needed to fully evaluate the effects of these cost increases. In the absence of these studies, the following qualitative discussion illustrates a range of possible effects to this sector.

The Idaho forest products industry achieved roughly $2 billion in sales of lumber and wood products and $540 million in sales of pulp and paper in 1992 (Idaho Forest Products Commission, 1999). In 1993, lumber production totaled about 1.86 billion board feet with an estimated wholesale value of $874 million. The majority of this economic activity is centered in north-central Idaho. In 1990, approximately 60 percent of Idaho's forest income was earned in the northern counties.

Projected transportation cost increases for wood products (pulp and waste paper, paper products, primary wood products) and wood chips and logs (fuel wood; wood chips, wood in the rough, lumber, forest products not elsewhere classified) shipped on the lower Snake River were developed by the DREW Transportation Workgroup (Table 6-24). Transportation costs were projected to increase by $2.5 million if the dams were breached and transportation on the lower Snake River were no longer possible. This would represent a 20 percent increase for the higher value added wood products commodity group, The cost for the logs and wood chips category would increase by 3 percent (Table 6-24).

Table 6-24. Projected Transportation Cost Increases for the North-Central Idaho Forest Products Industry (1998 dollars)

Product	2002 Volume in tons	Total Transportation Cost Increase ($)	Cost Increase per Ton ($)	Percentage Increase from Base Case Cost (2002)
Wood Products	66,000	1,064,591	16.13	20
Logs and Wood chips	694,000	1,481,295	2.13	3
Totals	760,000	2,545,886	na	na

Source: DREW Transportation Workgroup, 1999

North-central Idaho has a diverse mix of mills producing various degrees of value-added wood products such as wood chips, dimensional lumber, decking, and other forest products, as well as pulp and paper products. The byproducts of the milling process are bark, hogfuel, sawdust, and wood chips. These byproducts are consumed internally to generate electricity or heat, sold to a local pulp and paper mill, or shipped by barge to pulp mills in western Washington and Oregon.

Several wood products companies that use the Lewiston, Clarkston, and Whitman County ports. These companies use the existing system of barges to ship dimensional lumber, raw logs, wood chips, and other value-added wood products. Employment data is not readily available for these companies. The facilities that would be most potentially affected by dam breaching are the paper and three chipping mills.

A large pulp and paper mill operates three divisions (consumer products, pulp and paperboard, and wood products) and employs approximately 1,700 people in the Lewiston/Clarkston valley, with annual sales estimated to range from $500 to $650 million. This mill is linked to many of the region's other mills because it is the region's major consumer of wood chips and sawdust (Robison, McKetta, and Peterson, 1996). It is estimated that a total of 170,000 tons or one-third of their total paperboard production is shipped via the lower Snake River.

In the absence of an industry-specific study that details the specific volumes of goods shipped on the lower Snake River by individual forest products companies, the actual increased power costs, water supply and treatment costs, the financial health of each company, and the relationships between these companies, it is impossible to quantitatively estimate the magnitude of the impacts to individual companies and the industry as a whole. Overall, the magnitude of the projected transportation cost increase alone appears to be small in comparison to the value of the overall production from region. Possible reactions to these cost increases are summarized in Section 6.3.4.4.

7. Social Impact Analysis

7.1 Summary of Findings

Communities in the region of the lower Snake River can be characterized as primarily small rural towns that have moderate or low economic diversity and depend significantly on agricultural activities for their economic base. In addition to these rural communities, four areas of urban trade centers, Walla Walla, Pendelton/Hermiston, the Tri-Cities (Richland, Pasco, Kennewick), and the quad Cities (Lewiston, Clarkston, Pullman, and Moscow), provide high economic diversity and educational opportunities in the region. With the exception of the Tri-Cities region, both population and economic growth throughout the region have lagged behind general Pacific Northwest states and national growth trends. The two key industries that historically formed the base and currently provide an important component of the regional economy have been manufacturing of wood products and agricultural production. These two industries, though, have not been the engines of growth in the last decade, and agriculture particularly has experienced absolute declines in terms of employment and percentage of regional income. It is not anticipated that these sectors will be the engines of future regional growth. The agricultural sector will potentially be affected most significantly by Alternative 4, Dam Breaching.

The Social Analysis Report (Foster Wheeler Environmental, 1999) identified social impacts to nine focus communities, or case studies, taking into account the phases of project development for each of the alternatives under consideration to improve juvenile salmon migration through the four lower Snake River projects. These communities were chosen to capture a range of direct positive and negative impacts across types of communities and the geographic scope of the study area. This Social Analysis Report provides additional detail data and analysis to the conclusions presented in this section.

From the analysis of the nine case study communities, it appears that changes in the physical, biological, and economic human environment would have both adverse and beneficial impacts on communities throughout the study region. Each of the Alternatives under consideration would create winners and losers, both socially and economically, within and between communities and the subregions. Many of the economic and social losses for one community or group may present opportunities for gains by another community or group.

Major System Improvements, Alternatives 2 and 3

Alternatives 2, Maximum Transport, and 3, Major System Improvements, would have little effect on the economic and physical human environment for most communities throughout the region and would provide a degree of economic security for those communities and businesses (grain farms, bulk commodity shippers, and irrigated agriculture) that use the lower Snake River system. Some communities, particularly in the upriver region, that depend on the salmon and steelhead fishery both socially and economically would be adversely affected by the lower probabilities of salmon recovery. Overall changes in regional employment would be minor as a result of implementing these actions. They will consist primarily of employment associated with increased Corps spending. Additionally, all communities in the region would be adversely affected by the lower probability of salmon recovery and eventual delisting due to the continued Federal oversight of local and regional

economic development activities and the continuing uncertainty about the future of the lower Snake River projects.

Dam Breaching Alternative

Alternative 4, Dam Breaching, would change the economic and physical environment of the study region. Although the social and economic environment of the region is constantly changing due to market forces and demographic changes, this type of change to the human built environment would present economic uncertainty, stress, and fear for some residents of the region. For other residents, it would represent hope for recovering endangered anadromous fish populations.

Employment Impacts of Alternative 4

The overall employment effects of Alternative 4 would result in a net gain to communities in the upriver subregion, a net loss to communities in the reservoir subregion, and no change in the downriver subregion. The allocation of the total long-term employment changes under Alternative 4, including total jobs lost and net changes in employment, are presented by subregions in Tables 7-1 and 7-2. Table 7-3 shows the total short-term, primarily construction-related, employment changes by subregion. The regional economic analysis prepared for this study developed estimates for each year of the 100 year study period. High, medium, and low estimates were developed for project year 20 and presents the range—low, medium, high—of projected impacts for that year. This provides a different perspective to the estimates presented in Section 6, Regional Economic Analysis, which are point estimates based on mid-point numbers or "most likely" estimates, with averages shown when effects vary by year over a number of years.

The jobs presented in Tables 7-1 through 7-3 represent both full- and part-time employment. The standard conversion of full- and part-time jobs to full-time equivalents is 0.88. In other words, the overall job losses and gains shown in the tables could be multiplied by 0.88 to obtain a full-time equivalency (FTE) of employment. The conversion for the agricultural and service sectors would be slightly lower than the average (0.81) and slightly higher than the average for the government and transportation and public utilities sectors (0.96).

The total job losses forecast for each region would represent approximately 3.0 percent, 0.6 percent, and 0.3 percent of the reservoir, downriver, and upriver subregions' total employment, respectively, regardless of whether the high, medium, or low forecasts were considered (Table 7-1). The exception to this is the reservoir region where the low forecast would be approximately a 2.0 percent loss. Overall employment changes for the entire Pacific Northwest would range between 0.1 and 0.07 percent. This includes the low, medium, and high estimates. Most of these job losses are related to employment associated with irrigated agriculture on the Ice Harbor Reservoir, the Corps' operations of the four lower Snake River facilities, and the effects of increased power rates throughout the Pacific Northwest. Table 7-1 highlights only those jobs that would be lost as a result of implementation of Alternative 4 and does not include jobs that would be gained by less efficient energy production and grain transportation modes and increased travel and tourism activity.

As can be seen in Table 7-2 the combination of scenarios by subregion would not significantly change the net employment effects of Alternative 4. On the level of the Pacific Northwest region, total long-term net employment changes would range from a 0.02 percent decrease in the best case scenario to the worst case scenario of a 0.06 percent decrease in regional employment after 10

Table 7-1. Forecast Direct, Indirect and Induced Long-term Employment Losses by Subregion (Alternative 4)1/,2/,3/

Range of Employment Losses	PNW Job Losses	PNW Jobs	Losses as a Percentage of PNW Employment	Reservoir Region Losses	Reservoir Jobs	Losses as a Percentage of Reservoir Subregion Employment	Downriver Losses	Downriver Jobs	Losses as a Percentage of Downriver Region Employment	Upriver Losses	Upriver Jobs	Losses as a Percentage of Upriver Employment
High	(6,621)	5,703,840	(0.116)	(2,681)	92,535	(2.90)	(906)	151,124	(0.60)	(253)	75,081	(0.34)
Medium	(6,047)	5,703,840	(0.106)	(2,673)	92,535	(2.89)	(887)	151,124	(0.59)	(245)	75,081	(0.33)
Low	(4,166)	5,703,840	(0.073)	(1,717)	92,535	(1.86)	(463)	151,124	(0.31)	(239)	75,081	(0.32)

1/ Employment losses outside of lower Snake River region primarily related to the impacts of increased power rates on households, farms, industry, and commercial consumers throughout the PNW. The uncertainty associated with these estimates corresponds to the uncertainties faced by each of the DREW study teams.

2/ Percentages of employment changes calculated based on the existing 1997 employment structure of the study area. Considering the recent and short-term projected economic growth in the region, these percentages should be considered conservative. Both gains and losses as percentages may be smaller considering the growing employment base, but this static snapshot provides a relative comparison of the impacts.

3/ Long term effects are those that are permanent and lasting through the period of analysis.

Table 7-2. Net Long-Term Changes by Subregion and Pacific Northwest (Alternative 4)1/,2/

	PNW Region Net		Reservoir Region		Downriver Region		Upriver Region	
	20 year net forecast	20 yr. % net change	20 year net forecast	20 year % net change	20 year net forecast	20 year % net change	20 year net forecast	20 year % net change
Net worst case (low gains/high losses)	(3,354)	(0.06)	(1184)	(1.28)	13	0.01	116	0.15
Net Best case (high gains/low losses)	(899)	(0.02)	(220)	(0.24)	455	0.30	129	0.17
Net most likely (low gains/med. losses)	(2,780)	(0.05)	(1176)	(1.27)	32	0.02	123	0.16

1/ Totals may not add up to regional summary due to the allocation of power impacts by population distribution. Positive impacts of recreation are constrained by DREW recreation team and A-Fish team estimates. The uncertainty associated with these estimates corresponds to the uncertainties faced by each of the DREW study teams and the regional model.

2/ Long term effects are those that are permanent and lasting through the period of analysis.

Table 7-3. Short-term Employment Changes by Subregion (Alternative 4)2/

Average Short-Term Gains1/	PNW Distribution (Jobs)	PNW % Change	Reservoir Impacts (Jobs)	Reservoir % Change	Upriver Impacts (Jobs)	Upriver % Change	Downriver Impacts (Jobs)	Downriver % Change
Average	20,790	0.36	9,536	10.31	2,294	3.06	8,959	5.93
Total Employment	5,703,840		92,535		75,081		151,124	

1/ Used mid-point or average number of jobs created as a result of short-term construction. A number of the impacts have a wide range of variation depending on the magnitude of construction and the length of the time period. The subregion totals differ from those presented in Table 6-19 because this presentation allocates all of the projected job changes to a subregion.

2/ Short term effects are those that could occur in 10 years.

years. The major factors driving this range of uncertainty are the estimates associated with power rate impacts and with recreational employment impacts. Again, the reservoir region would have the most significant decreases. The downriver region might also see a net decrease in employment from 0.051 to 0.036 percent. The upriver and downriver regions would have a positive change in regional employment ranging from a 0.15 to 0.17 percent increase for the upriver region to a 0.01 to 0.03 increase in the downriver region.

The incomes associated with these gains and losses would not be equal. Although the indirect and induced employment effects would ripple through all sectors of the regional economy, the income differences in direct employment could be identified. Lost direct employment would be associated with irrigated farm owners and full-time and seasonal workers, as well as Corps' employment related to the operations and management of the lower Snake River facilities. Direct employment gained would be associated with the operations and maintenance of new power plants and increased recreation and tourism. The average wage of Corps employees in the Walla Walla District is approximately $45,000; this is significantly above the regional per capita or median income. On the other hand, approximately 2,563 part-time and seasonal employees work on the farms on the Ice Harbor Reservoir. According to the Washington State Employment Security Department, the average hourly wage for seasonal agricultural workers in southeastern Washington was $6.27, with or an annual salary of $12,500 for full-time workers.

According to the IMPLAN model, the average income per direct, indirect, and induced job created by the operations of new power facilities was approximately $27,000 per year. Because recreation and tourism are not distinct industries, the median wage in Riggins, Idaho, a town with a strong recreation and tourism base, was used to examine the income effects of increased employment in recreation. In 1994, earnings per worker were approximately $19,000 dollars, although this may be somewhat misleading because Riggins is an isolated community with a relatively low cost of living. Short-term construction employment is forecast assuming that changes are made to existing infrastructure. None of the changes made is included in the Corps implementation plan, except for those expenditures associated directly with implementation of Alternative 4.

Table 7-3 shows that average short-term employment change would contribute significantly to each of the study subregions. The reservoir region would experience approximately a 10 percent increase in regional employment, while the downriver and upriver subregions would experience increases of 5.9 and 3.0 percent, respectively.

Impacts by Subregion

The most significant social impact to the downriver region communities including Pasco, Kennewick, and Umatilla, would be the potential lost agricultural employment from the Ice Harbor pool and the supply uncertainty faced by food processors and fruit packers. This direct employment loss might be partially offset by the expected increase in transportation and power-generation-related employment. Increased flow of commerce into these communities would contribute to traffic safety and congestion concerns. Another significant social impact is the fear that the breaching of the four lower Snake River projects would lead to the inevitable breaching of projects on the Columbia River and the effect of this fear on investments in the region.

The most significant impacts to communities in the reservoir region, including the case study communities of Pomeroy, Colfax, and Clarkston, would be the loss of Corps employment and the increased financial pressure on family farms caused by increased transportation, storage, and

handling costs for agricultural products. This added pressure to an already depressed agricultural sector might lead to an increased rate of farm consolidation for those farms not fully owned and those with a high debt-to-equity ratio, increased stress in the farm sector, and an increased rate of loss for rural farm population. This impact would significantly affect the largest number of communities in both the reservoir and upriver regions. In addition, communities in the reservoir region would be affected by the short-term loss of recreation access and the increased flow of truck traffic on the two east-west highways (US12 and SR 26) that cross the region.

The most significant impact to communities in the upriver subregion including Lewiston, Orofino, and Riggins would be the expected increase in the recreation and tourism industry with a free-flowing river condition. Lewiston and Orofino face economic uncertainty because it is unknown how significantly the loss of river navigation would affect the forest products industry. Additionally, the effects of increased transportation costs to farmers would be the most significant in Latah, Nez Perce, Idaho, and Lewis counties in Idaho.

Effects Widely Dispersed Across the PNW

Although electrical rate increases would be expected across all communities and industries in these subregions, as well as across the states of Washington, Oregon, Idaho, and Montana, the estimated 2.8 to 9.4 percent increase for residential rates is relatively small considering the existing low electricity costs. These increases are not expected to have significant social or economic impacts in any of the focus communities under consideration, although those communities that purchase electricity from rural cooperatives or public utility districts might be more at risk for the higher rate increases. Effects on the aluminum industry are unknown, but significant regional impacts could occur, depending upon who pays the increased costs.

Responses to a Changed Social Environment

The responses of communities, industries, and individuals to these changes in the physical, biological, and economic human environment might be categorized as economic and social. According to the Independent Economic Analysis Board of the Northwest Power Planning Council, the response to the economic impacts described above would either be a migration of individuals and businesses seeking new opportunities, or the reemployment of human and capital resources in their next-best use within the community (IEAB-NWPPC, 1999).

Social responses might include mobilizing resources to minimize adverse impacts, charting a new vision for the community, and taking advantage of new opportunities. Each community is distinct in its ability to respond to these challenges and overcome obstacles in its developmental path. Community size has been identified as a critical factor to a community's ability to adapt to change. Communities may have less diverse economic bases and fewer human resources to draw upon in challenging times. In the case of communities affected by potential changes, almost all of them have recently responded to economic booms and busts, as well as declining returns in the historically important agricultural sector. Social and economic impacts projected by this study, in the context of recent historical changes and each community's potential responses, are discussed in Section 6.4.

7.1.1 Summary Comparison of Impacts by Community

The significance of changes in the physical, biological, and socioeconomic environment in each of the nine focus communities was evaluated based on the criteria indicated in Table 7-4. The

significance of the socioeconomic factors was determined as the difference between each alternative and the base case, Alternative 1, in both the short-term predevelopment and implementation and the long-term post-implementation phases. Some of the criteria are based on quantitative economic forecasts developed by other study teams, while others are based upon descriptions of physical changes in the study region. The economic impacts were estimated by disaggregating the regional employment and income effects identified in the regional study. Other criteria and the qualitative and quantitative data were developed specifically in the DREW Social Analysis Report (DREW Social Analysis Workgroup, 1999). A thorough literature review was conducted to determine how rural agricultural communities in eastern Washington and throughout the United States have been affected by economic and infrastructure changes. For more details on the methodology and the literature review, see the DREW Social Analysis Report (DREW Social Analysis Workgroup, 1999).

7.1.2 Mitigation Potential

Total long-term employment losses across the Pacific Northwest forecast by the regional study indicate that between approximately 4,166 and 6,621 jobs might be lost as a result of Alternative 4. Total jobs gained are forecast between 3,796 and 4,722 after 20 years. Some of these job losses represent identifiable dislocated or displaced workers, while others (such as those related to power rate increases) are dispersed and difficult to identify. Of these losses, approximately 3,500 direct job losses might be classified as dislocated. In addition to these losses, the regional study estimated gains in recreation and tourism and associated industrial sectors and in power generation and related sectors. These jobs, in addition to the short-term construction jobs created by Alternative 4, might provide new economic opportunities in the region that would help mitigate potential losses. Direct, indirect, and induced employment losses based on middle estimates are distributed throughout the three subregions as follows: upriver–245 jobs, reservoir–2,673, downriver–887. The state distribution of employment losses based on middle estimates is approximately 4,585, 582, and 810 for the states of Washington, Idaho, and Oregon, respectively.

Approximately 67 communities in the lower Snake River subregion would be adversely affected by increased transportation costs. An additional 15 communities outside the designated study area would also be affected by increased transportation costs. These affected communities are primarily smaller than 1,000 inhabitants, but would also include the larger cities of Lewiston, Clarkston, Pasco, Kennewick, Richland, and Walla Walla.

Overall adverse community level social impacts within the nine case study communities, as identified through the Social Analysis Report and through Community-Based Impact Assessments (Harris, et al., 1999) conducted by the University of Idaho, include the following:

1. Decreased net farm income and increased financial pressure on dryland farmers throughout the region, particularly for those farms close to the Lower Snake River
2. Risk of increased consolidation of family farms and decline in rural farm population
3. Decreased county property tax base in 20 regional counties from decreased farm land value and potential loss of irrigated lands
4. Dislocated full-time and seasonal workers from Ice Harbor irrigated agricultural lands and loss of a source of local school revenue for communities close to the reservoir
5. Minor realignment of communities' economic bases and changed potential for future growth.

Table 7-4. Significance of Changes in the Physical, Biological, and Socioeconomic Environments

Alternative	Indicators/Impact Measure	Evaluation Criteria	Clarkston	Colfax	Kennewick	Lewiston	Orofino	Pasco	Pomeroy	Riggins	Umatilla
	Power										
4	Residential Rate Increases	Residential Rate Increase > 5 percent			X			X			
4		Residential Rate Increase < 5 percent	X	X		X	X		X	X	X
4	Rate Employment Impacts	Decrease in Employment > 1 percent									
4		Decrease in Employment< 1 percent	X	X	X	X	X	X	X	X	X
4	Power Provider Rate Risk	Public Owned Utility			X			X		X	
4		Investor Owned Utility	X	X		X	X		X		X
4	Fixed Income Ratepayers	Poverty Rate >10 percent of all families	X		X			X		X	X
4		Poverty Rate < 10 percent of all families		X		X	X		X		
4	New Power Plant Operation	Increase in Employment > 1 percent									
4		Increase in Employment < 1 percent			X			X			X
4	ST: New Plant Construction	Increase in Regional Employment > 5 percent			X			X			X
4		Increase in Regional Employment < 5percent									
4		Within 50 miles of Potential Plant Siting			X			X			X
	Recreation										
4	Non-fishing River Recreation	Increase in Employment> 1 percent	X	X					X		
4		Increase in Employment < 1 percent			X	X		X			
4		Short-term Displacement	X	X	X	X		X	X		
4		Short-Term Crowding			X			X			X
4	Anadromous Fishing Recreation	Increase in Employment > 1 percent								X	
4		Increase in Employment < 1 percent	X	X	X	X	X	X			
4		Short-term Displacement	X			X	X	X			
4		Short-Term Crowding					X	X			
4		Local Fishing Opportunities	X	X	X	X	X	X	X	X	X
4	Site Access	Decrease in Site Access > 25 percent	X	X		X			X		
4		Decrease in Site Access <25 percent			X		X	X		X	X

ST=short-term employment associated with construction.
Uncertainty related to employment percentages is a result of uncertainties faced by other DREW workgroups, dynamics of local economies, and methodology for allocating regional impacts to local geographic area.

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Table 7-4. Significance of Changes in the Physical, Biological, and Socioeconomic Environments

Alternative	Indicators/Impact Measure	Evaluation Criteria	Clarkston	Colfax	Kennewick	Lewiston	Orofino	Pasco	Pomeroy	Riggins	Umatilla
4	Site Services	Decrease in Site Services> 25 percent	X	X		X			X		
4		Decrease in Site Services< 25 percent			X		X	X		X	X
4	Elderly Recreationists	Over 65 years > 20 percent	X	X					X		
4		Over 65 years < 20 percent			X	X	X	X		X	X
	Transportation										
4	Transportation Related Employment	Increase in Employment > 1 percent									
4		Increase in Employment < 1 percent	X	X	X	X	X	X	X		
4	Farm Spending Related Employment	Decrease in Employment > 1 percent		X							
4		Decrease in Employment < 1 percent	X			X	X		X	X	
4	Dryland Farm Income	Decrease in Total County Farm Income > 10 Percent		X						X	
4		Decrease in Total County Farm Income < 10 percent	X			X	X	X	X		
4	County Property Tax Revenue	Decrease in Property Tax Revenue > 2 percent									
4		Decrease in Tax Revenue < 2 percent									
4	County Sales Tax Revenue	Increase in Sales Tax Revenue									
4		Decrease In Sales Tax Revenue									
4	ST: Road, Rail and Infrastructure	Increase in Employment > 1 percent	X	X	X	X			X		
4		Increase in Employment < 1 percent					X	X			
4	Road, Rail and Infrastructure Maintenance	Increase in Employment > 1 percent									
4		Increase in Employment < 1 percent									
4	Grain Transportation Costs	Increase in Avg. Cost > 15 cents per bushel	X	X		X	X			X	
4		Increase in Avg. Cost < 15 cents per bushel						X	X		
4	Farm Consolidation (Dryland)	Risk of Increased rate of Farm Consolidation	X	X		X	X		X	X	
4	Transportation Costs (other Shippers)	Increase in Transportation Cost	X	X		X	X		X	X	
4	Transportation Capacity Uncertainty	Increase in Transportation Uncertainty	X	X	X	X	X	X	X	X	
4	Highway Congestion	Increase in Traffic Volume > 2 percent						X	X		
4		Increase in Traffic Volume < 2 percent	X	X	X	X					
4		Decrease in Traffic Volume					X			X	

ST=short-term employment associated with construction.
Uncertainty related to employment percentages is a result of uncertainties faced by other DREW workgroups, dynamics of local economies, and methodology for allocating regional impacts to local geographic area.

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Table 7-4. Significance of Changes in the Physical, Biological, and Socioeconomic Environments

Alternative	Indicators/Impact Measure	Evaluation Criteria	Clarkston	Colfax	Kennewick	Lewiston	Orofino	Pasco	Pomeroy	Riggins	Umatilla
4	Highway Safety	Increase in Highway Safety					X			X	
4		Decrease in Highway Safety	X	X	X	X		X	X		
	Water Supply										
4	Dislocated Agricultural Workers/Spending	Decrease in Employment > 1 percent			X			X			
4		Decrease in Employment < 1 percent									X
4	Farm Income	Decrease in Total County Farm Income > 10 Percent						X			
4		Decrease in Total County Farm Income < 10 percent									
4	County Property Tax Revenue	Decrease in Property Tax Revenue > 2 percent									
4		Decrease in Tax Revenue < 2 percent									
4	ST: Pump/Well Modifications	Increase in Employment > 1 percent	X			X					
4		Increase in Employment < 1 percent		X	X		X	X	X		
4		Increased costs for well irrigators/users	X			X		X	X		
	Effects on Food Processors	Decrease in local produce			X			X			X
	Implementation/Avoided Costs										
4	ST: Implementation Employment	Increase in Employment > 1 percent	X	X			X		X		
4		Increase in Employment < 1 percent			X	X		X			X
3		Increase in Employment < 1 percent	X	X	X	X	X	X	X		
4	Outside Workers	Increase in Outside Workers >10 percent	X						X		
4		Increase in Outside Workers < 10 percent		X	X	X		X			
4	Human Movement Patterns	Loss of Project Bridges within 50 miles		X	X			X	X		
4	Operations Employment	Decrease in Employment > 1 percent		X					X		
4		Decrease in Employment < 1 percent	X		X	X		X			X
3		Increase in Employment > 1 percent									
3		Increase in Employment < 1 percent	X		X	X		X	X		X
	Anadromous Fish Recovery										
4/3	ST: Social Cohesion	Increased Social Cohesion		X	X			X	X	X	X

ST=short-term employment associated with construction.
Uncertainty related to employment percentages is a result of uncertainties faced by other DREW workgroups, dynamics of local economies, and methodology for allocating regional impacts to local geographic area.

Table 7-4. Significance of Changes in the Physical, Biological, and Socioeconomic Environments

Alternative	Indicators/Impact Measure	Evaluation Criteria	Clarkston	Colfax	Kennewick	Lewiston	Orofino	Pasco	Pomeroy	Riggins	Umatilla
4/3		Decreased Social Cohesion	X			X	X				
4	Recovery Uncertainty/Risk	Lower Uncertainty of Salmon Recovery	X	X	X	X	X	X	X	X	X
3		Higher Uncertainty of Salmon Recovery	X	X	X	X	X	X	X	X	X
3	Business Uncertainty/Risk	Lower Economic Uncertainty/Risk	X	X	X	X	X	X	X	X	X
4		Higher Economic Uncertainty/Risk	X	X	X	X	X	X	X	X	X
3	Extinction Risk/Existence Value	Higher Extinction Risk	X	X	X	X	X	X	X	X	X
4		Lower Extinction Risk	X	X	X	X	X	X	X	X	X
	Other Social Effects										
4	Population Impacts	Decrease in Population > 5 percent						X			
4		Decrease in Population < 5 percent		X	X				X		
4		Increase in Population > 5 percent									
4		Increase in Population < 5 percent	X			X	X			X	X
4	Total Long-Term Employment	Employment Losses > 5 percent									
4		Employment Losses < 5 percent	X	X	X	X	X	X	X		X
4		Increase Net Employment > 1 percent									
4		Increase Net Employment < 1 percent	X			X	X			X	X
4		Decrease Net Employment > 1 percent									
4		Decrease Net Employment < 1 percent		X	X			X	X		
4	Total Short-Term Employment	Increase in Employment > 5 percent	X	X					X		
4		Increase in Employment < 5 percent			X	X	X	X			X
4	Total Subregional Employment	Increase Net Employment > 1 percent									
4		Increase Net Employment < 1 percent			X	X	X	X		X	
4		Decrease Net Employment > 1 percent	X	X					X		
4		Decrease Net Employment < 1 percent									X
4	Aesthetics	ST Exposed Shoreline	X	X	X	X	X	X	X		
4		LT Revegetated Shoreline	X	X	X	X	X	X	X		

ST=short-term employment associated with construction.

Uncertainty related to employment percentages is a result of uncertainties faced by other DREW workgroups, dynamics of local economies, and methodology for allocating regional impacts to local geographic area.

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Many of these community-level and employment impacts would caused by increased transportation costs for trucking grain and by the loss of irrigated agriculture on the Ice Harbor Reservoir at the costs described in the Navigation and Water Supply reports. These impacts could be minimized or eliminated in part by mitigation spending to modify the irrigation pumps and direct upgrades to expand rail capacity in the region. Another strategy would be to directly subsidize the farms currently shipping on the lower Snake River. The costs of these mitigation measures have been discussed in the transportation and irrigation reports. In the absence of direct mitigation, employment- and community-level impacts could be mitigated or minimized as described below and as illustrated in the Mitigation Section of the Social Analysis Report.

Potential mitigation expenditures for 3,500 dislocated workers have been estimated at between $45.1 and $48.1 million to address employment losses through job retraining, income support, and academic training. Potential mitigation for 82 affected communities has been estimated at between $4.3 and $12.9 million, based on previous Federal and state mitigation expenditures used to address the impacts of free trade, old-growth forest conservation, and dislocated workers.

Under Alternative 2, the lower probability of salmon recovery and eventual increased or resumed harvest would affect approximately 10 communities in the lower Snake River region, an unknown number of tribal communities, and an unknown number of coastal fishing communities. No estimate for future mitigation is given under this alternative. One proxy might be the opportunity cost of foregone fishing revenue as forecast by the Recreation Team and the Anadromous Fish Economic Team.

7.1.3 Unresolved Issues

At this time, the assessment of social impacts to the region and to focus communities is incomplete due to unresolved key issues such as the following:

1. Lack of an industry-specific study detailing how the forest products industry of North Central Idaho might be affected by increased transportation costs
2. Actual magnitude of net county tax impacts resulting from increased road maintenance activity and decreased agricultural land values for dryland farms and irrigated farms under Alternative 4
3. The expected rate response for alternative modes of transportation and the effects of the rate changes on shippers under Alternative 4
4. The degree of linkages between agricultural products from Ice Harbor and downriver food processors and alternative supply quantities under Alternative 4.

The remainder of this section presents the purpose and methods of the study, a characterization of the study region, a brief description of the case study community baselines, a more detailed comparison of alternatives by community and potential responses, and a discussion of the compensation or mitigation potential.

7.2 Introduction

7.2.1 Purpose

The purpose of this Social Analysis Section is to examine the range of potential social impacts that may occur as a result of implementing one of the four alternatives. This report focuses on the

potential community level impacts resulting from changes in the local and regional biological, economic, and physical environment. While other reports addressing the economic impacts of the proposed alternatives focus on national economic development (NED), this report attempts to outline the distributional and equity effects on specific communities within the broader regional context. Communities are the focus of this report because it is at this level that social impacts resulting from resource policy changes may be most keenly felt (Force and Machlis, 1997). This study has been designed to meet the requirements specified in the WRC Guidelines (WRC, 1983). The key issues addressed include the following:

- What the social impacts will be and when (timing)
- Who will be affected
- How they will be affected (beneficial/adverse)
- How much they will be affected
- How the communities may respond.

By answering these questions through the use of qualitative and quantitative data in the examination of nine case study communities, the social analysis provides a greater understanding of the anticipated impacts and highlights the need for and location of potential mitigation measures. Uncertainty exists throughout this analysis because of the uniqueness of the proposed actions and the unknown nature of how markets, communities, and political entities will respond to the implementation of these actions, particularly the natural river drawdown alternative. The degree and magnitude to which the proposed alternative will affect communities throughout the region depends in large part on how these communities, industries, families, and individuals respond to potential and actual changes.

7.2.2 Scope

The scope of the analysis in this report covers the potential social impacts associated with the four main alternatives under consideration by the Corps. These alternatives include the base case or existing condition (Alternative 1), existing conditions with maximum transport (Alternative 2), major system improvements (Alternative 3), and natural river drawdown or dam breaching (Alternative 4). The effects of Alternatives 2 and 3 on the human environment generally do not differ significantly, and will be discussed together.

The geographic scope of the analysis is limited to communities within the lower Snake River region. This region includes the counties listed in Table 7-5 and approximately 101 communities within these counties. For the purpose of analysis, the potentially affected lower Snake River region was divided into three subregions to explore the differential effects of the proposed alternatives: downriver, reservoir, and upriver. The counties that comprise these subregions and the combined lower Snake River study area are identified in Table 7-5. For a more complete description of the definition, justification, and delineation of the subregions see the Regional Economic Report (AEI, 1999).

Table 7-5. Regional Analysis Study Area

Downriver Subregion	Reservoir Subregion	Upriver Subregion
Oregon	**Washington**	**Idaho**
Gilliam	Adams	Clearwater
Hood River	Asotin	Custer
Morrow	Columbia	Idaho
Sherman	Garfield	Latah
Umatilla	Walla Walla	Lemhi
Wasco	Whitman	Lewis
		Nez Perce
Washington		Valley
Benton		
Klickitat		**Oregon**
Skamania		Wallowa
Franklin		

There are three distinct time phases to this analysis. Impacts do not occur just during the most intensive phases of project implementation, but also before and after implementation (Grambling and Freudenburg, 1992). The first phase includes the planning and decision-making period of the feasibility study from the initiation of the feasibility study and environmental impact statement (EIS) scoping to the final selection of a preferred alternative. The second phase includes the implementation phase, proposed from 2002 to 2012, depending on the alternative selected (Corps Implementation Report, 1999). The third phase includes the post-implementation social effects. Potential community-level impacts were examined across these three phases, but were limited to an overall study period of 20 years because forecasting the non-economic social impacts of the alternatives would be limited by the high degree of variability of social systems.

The scope of this social analysis neither provides a comprehensive assessment of all the communities within the defined study region, nor are the communities selected for this analysis representative of all communities in the region. Rather, the intent of the study is to provide decision-makers with information regarding the various impacts across a range of case study communities likely to be affected by the proposed alternatives. Tribal communities are not examined as part of this study. A study entitled "Tribal Circumstances and Perspectives," prepared by the CRITFC, documents the tribal perspective concerning the potential social, cultural, and economic effects of the proposed alternatives on tribal populations (Meyer Resources, 1999).

7.2.3 Methodology

In order to address the key study questions, the following steps were taken to obtain reliable information on potential social impacts:

1) Develop an understanding of the issues raised in the original scoping the Corps conducted in 1995 and the public information meetings the Corps conducted during this study.

2) Select key focus communities to capture the range of possible direct impacts.

3) Select appropriate social indicators for the types of anticipated social impacts.

4) Describe the trends and history of the region and case study communities.

5) Develop estimates of potential impacts, the magnitude of these impacts, and the range of community responses using information provided by the DREW work teams, NMFS, secondary data analysis, key informant interviews, and a thorough literature review.

This analysis is supplemented by information obtained through a series of interactive community forums, which included each of the focus communities. The community forum information includes each community's perceptions of its history, an assessment of its current situation, and a projection of potential social impacts under each of the proposed alternatives. For more information on the methodology and findings of the community-based assessments, see Harris et al., 1999.

7.2.3.1 Selection of Focus Communities

Secondary data sources, including the 1990 Census of Population and Housing and the 1992 Census of Agriculture, as well as preliminary impacts identified by the Drawdown Regional Economic Workgroup (DREW) study teams, were consulted to evaluate communities for inclusion as case study focus communities. The study team examined the potential impacts of the three alternatives under consideration to identify a group of focus communities that met the following criteria:

- Communities that might experience large potential impacts (positive or negative) as a result of the project alternatives
- Communities that are diverse in size, economic activity, and potential socioeconomic impacts (level, type, and timing of impacts).

Table 7-6 lists the communities selected as focus communities for this study.

7.3 Characterization of Study Region and Communities

7.3.1 Characteristics of Communities

The communities located throughout the study area are diverse in terms of their size, economic activity, and relationship to the lower Snake River. The purpose of this section is to describe these basic characteristics in order to put the analysis of the focus communities into the context of the other 101 communities in the study region.

Communities in Washington State (45) represent nearly 50 percent of the communities in the study region, with Oregon and Idaho almost equally represented with 29 and 27 communities, respectively. With the exception of four communities in the upriver region, the Oregon communities are downstream of the Lower Snake River Project. Two-thirds of the communities in Washington are located directly around the reservoirs. Approximately half of the Idaho communities are located at the eastern, upstream end of the reservoirs.

Table 7-6. Selected Focus Communities

Region	Focus Community		Size	Primary Economic Activities	Primary Direct Impacts
Reservoir	WA:	Clarkston	6,860	Medical services, wholesale & retail trade	Navigation, implementation, recreation, A-fish, power
		Colfax	2,865	Agriculture, state/local government, wholesale & retail trade	Transportation, recreation
		Pomeroy	1,475	Agriculture, state/local/ Federal government	Navigation, recreation, implementation
Downriver	WA:	Kennewick	48,010	Wholesale & retail trade, services, F.I.R.E	Navigation, recreation, irrigation, implementation, power
		Pasco	22,370	Agriculture, transportation	Navigation, recreation, irrigation, implementation, power
	OR:	Umatilla	3,155	Agriculture, state/local/ Federal government	Recreation, navigation, irrigation
Upriver	ID:	Lewiston	30,271	Manufacturing, wholesale & retail trade	Navigation, implementation, A-fish, power, recreation
		Orofino	3,122	Timber, agriculture, state/local/Federal government	A-fish
		Riggins	495	Travel & tourism, ag., state/local/Federal government	Recreation, A-fish

7.3.1.1 Population

The total population of the study area was approximately 582,124 in 1995. Population is distributed unevenly among the 25 counties and three subregions that comprise the study area. The downriver subregion, which extends from the confluence of the Snake and Columbia rivers to below Bonneville Dam, is the most populated, accounting for 278,429, or approximately 48 percent, of the study region's 1995 population.

In general the geographic area of northeastern Oregon, southeastern Washington, and north central Idaho is sparsely populated and rural. The size of communities ranges from small rural towns with populations less than 200 to cities with populations from 8,000 to almost 50,000. In general the communities in the lower Snake River study area are small. Sixty-six percent have populations lower than 1,500, and 60 percent have populations lower than 1,000. The major population centers are the Tri-Cities (Richland, Kennewick, and Pasco), Walla Walla, the Quad-Cities (Pullman, Moscow, Lewiston, and Clarkston), and Hermiston/Pendelton. Only five communities in the study region have populations that exceed 20,000. These larger population cities serve as regional trade and educational centers and provide a diversity of employment opportunities from manufacturing and professional services to tourism. These cities make up a large share of the economically diverse communities in the region.

7.3.1.2 Population Trends

Most rural areas in the dryland agricultural region of the Palouse (eastern Washington and north central Idaho) exhibited very slow growth over the 1980s and 1990s, while some rural areas offering high quality scenery and recreation have grown rapidly since 1990 (Johnson and Beales, 1994). Almost all the communities in the subregions have increased in population since 1990 and are expected to see moderate population growth over the next 15 years (Idaho, Washington, and Oregon State Population Estimates, 1996 and 1997).

7.3.1.3 Economic Characteristics

The economy of the Pacific Northwest has undergone substantial change over the past three decades. In terms of job formation it has grown much faster than the nation as a whole with total employment in the states of Washington, Oregon, and Idaho increasing by more than 210 percent. Employment in the 25-county study area increased by about 74 percent from 1970 to 1995. The total number of jobs in both the region and the study area has increased even as employment in historically important job sectors, such as manufacturing, logging, mining, farming, and ranching, has declined or remained stagnant. At the aggregate level, employment in the study area increased in nearly all sectors between 1970 and 1995. These patterns appear to be broadly similar across all three subregions, with absolute increases in all sectors with the exception of the farm and military sectors in the reservoir and upriver subregions and the mining sector in the downriver subregion. Employment in the farm sector declined by 14.1 and 20.9 percent in the reservoir and upriver subregions, respectively. The downriver subregion, by contrast, experienced a 9 percent increase in farm employment.

Most of the region's towns are small and, therefore, have narrow economic bases with fewer industries and fewer firms per industry than larger communities. Agriculture dominates in these small communities. Almost half of the communities in the region have 20 percent or more of their employment in agriculture, while 68 percent of the communities have 11 percent or more employment in the agricultural sector.

Per Capita Income

Average per capita income in the 25-county study area was $17,570 in 1995, with little variation across the three subregions. The states of Washington, Oregon, and Idaho had respective per capita incomes of $23,974, $21,915, and $19,199 in 1995. U.S. per capita income in 1995 was $23,359. The below average per capita income in the region indicates that many of these counties exhibit relatively high levels of poverty and unemployment.

Sources of Personal Income

Nonfarm earnings are the largest source of personal income in all three subregions. In 1995, nonfarm earnings as a percentage of total personal income ranged from 55.3 percent in the reservoir subregion to 65 percent in the downriver subregion.

Land Tenure Characteristics

Agricultural land tenure has undergone significant changes in all three subregions. In all cases, these changes have involved a decrease in the number of farms and an increase in average farm size. The downriver subregion has the largest number of farms and acres farmed of the three subregions. Between 1959 and 1992, this subregion lost 1,279 farms or 18.4 percent of the 1959 total. The reservoir and upriver subregions over this period lost 1,544 and 1,537 farms, respectively, or 34.1 and 32.6 percent of their 1959 totals.

This has not, however, been a simple linear decline. Rather, all three subregions experienced both increases and decreases in the number of farms between 1959 and 1992. The average size of farms also fluctuated over this period. In general, the trend has been toward increasing farm size in all three subregions.

7.3.2 Focus Community Baseline Profiles

Community profiles were prepared in the Social Analysis Report (Foster Wheeler, 1999). The profiles describe why each community was selected and provide an overview of historical community trends. They also outline each community's social, cultural, and economic relationship to the lower Snake River. Information related to four dimensions of community life—the people, the economy, the place, and vision and vitality—from 1970 to the present is also presented in these profiles. The information from these profiles provides the basis for evaluating the potential impacts and community responses. Much of this information is included in case-by-case discussions in Section 7.4. To organize the assessments of social impacts, communities were organized by these four dimensions of community. The people (demographics) dimension relates to the characteristics of individuals or households in the community and changes. The economic (jobs and wealth) dimension relates to the major businesses and sources of jobs in the community. The place (character) dimension refers to the built and natural environment of the community. The vision and vitality (organization and leadership capacity) dimension refers to the characteristics of the community's social organizations and ability to accomplish goals. The following sections provide a brief description of the community selection criteria and community history in order to frame the subsequent discussion of community-level impacts for the salmon recovery alternatives under consideration.

7.3.2.1 Clarkston, Washington

Clarkston is located in Asotin County, across the Snake River from Lewiston at the confluence of the Snake and Clearwater rivers. It was selected as a focus community because of anadromous fish runs, navigation, construction, and recreation opportunities along the Snake River.

History

In 1899, a bridge across the Snake River connected Lewiston and Jawbone Flats, the area officially incorporated as Clarkston in 1902. Agriculture, particularly berry production, dominated the town's economy in the early 1900s. By the 1950s, agricultural production grew to include grains and hay, peas, and other fruits. Livestock were also raised. Transportation was by railroad and boat which brought supplies up from Portland and grain down on the return trip. As water transportation on the Snake improved into Hells Canyon, Clarkston became a gateway for tourists. Lower Granite Dam was completed in 1975, flooding much of the fruit orchards and beef processing plants along the

river. A second bridge linking Clarkston and Lewiston was constructed in 1982. Today, Clarkston remains active as a regional trading center via its port, while agricultural production, outdoor recreational opportunities, and a growing retiree population add to its diversity.

7.3.2.2 Colfax, Washington

Colfax is located in Whitman County in the heart of the Palouse, the dryland wheat, barley, pea, and lentil region of eastern Washington and north central Idaho. It is approximately 19 miles north of the lower Snake River. It was selected as a focus community primarily because of navigation and recreation opportunities and access.

History

Incorporated in 1870, Colfax is the oldest town in eastern Washington. It was originally a sawmill town with cattle ranches and farms but, over the years, agriculture became the primary industry. Colfax became the county seat in 1871. A series of floods and fires threatened to destroy the community, but the residents rebuilt. In 1963 the Corps constructed a concrete flood control project to eliminate the flooding problem in the downtown area. With the arrival of slack water, the Port of Whitman County established new sites on the lower Snake River at Almota and Wilma. Colfax has recently completed a downtown revitalization project to widen Main Street, beautify the downtown, and enhance the business climate. The Port has also recently established a small industrial park on the outskirts of town.

7.3.2.3 Pomeroy, Washington

Pomeroy is located in Garfield County approximately 15 miles south of the lower Snake River in southeastern Washington. US 12 passes through town and connects Pomeroy to Clarkston and Lewiston to the east and Walla Walla and the Tri-Cities to the west. Pomeroy was selected because of navigation and recreation concerns.

History

Established in 1864, Pomeroy quickly experienced a rapid wave of population migration due to its location on the stagecoach line between the towns of Walla Walla and Lewiston. The economy was based primarily on cattle and vegetable farming. By 1878, the town had grown into a service and trade center containing a flour mill, retail stores, and a hotel. Arrival of the Starbuck-Pomeroy rail branch in 1885 further expanded Pomeroy's population, while serving as the major source of transportation for agricultural products. A pea cannery was built in 1942 and remained operational until the 1960s. The construction of Little Goose Dam in 1970, followed by Lower Granite Dam in 1975, significantly increased the local population and economic base in Pomeroy, as construction workers and their families moved in. The rail line was abandoned in 1981. In the 1990s, Pomeroy experienced many infrastructure improvements to its Main Street.

7.3.2.4 Kennewick, Washington

Kennewick is located in Benton County across the Columbia River from Pasco. It was selected as a focus community because of navigation, recreation, irrigation, and power concerns.

History

Incorporated in 1904, Kennewick is the largest community of the Tri-Cities. It began as a predominantly agricultural-driven economy, linked to the Northern Pacific Railroad route which moved its products to markets. World War II brought new prosperity to the region. In the 1940s, the plutonium production facilities at the Hanford Project were created. Hanford employees greatly expanded Kennewick's population, and the retail base grew to meet the needs of the increasing population. With the development of the Columbia Basin Project, irrigated agriculture expanded around the community, contributing to its rapid growth. Suspension of work at Hanford in the early 1980s and downsizing in the mid-1990s have greatly affected the economy of the community.

7.3.2.5 Pasco, Washington

Pasco is located in Franklin County to the north of the confluence of the Snake and Columbia rivers. Pasco and the other Tri-Cities create a hub of human and commodity movements through the lower Columbia Basin. Pasco was selected as a focus community because of water supply issues, navigation/transportation, power, recreation opportunities and sites, and anadromous fish runs.

History

Officially incorporated in 1891, Pasco attributes its establishment and early growth to railroad construction near the Snake and Columbia rivers in the 1870s. Steam-powered boats provided transportation into the region before the arrival of the railroad. Pasco soon moved from a single economy of rail to livestock and agricultural production made possible by pumping water from the rivers for irrigation in the 1890s. A more intensive irrigation project was developed in 1910. Airmail service to Pasco began in 1926, and a new airport by the rail was dedicated in 1929. In 1943, the Hanford nuclear project began. Although Pasco is located on the opposite side of the Columbia River from the Hanford facilities, it did receive some population and economic spillover, particularly with the 1985 creation of the I-182 highway bridge which connects Pasco to Richland. Suspension of work at Hanford in the early 1980s and downsizing in the mid-1990s have adversely affected the economy of the community. Work on environmental restoration in Hanford continues to provide economic benefits to Pasco. Dry land and irrigated agriculture in the surrounding countryside continues to play an important role in Pasco's development.

7.3.2.6 Umatilla, Oregon

Umatilla is located in Umatilla County, downstream from the confluence of the Snake and Columbia rivers on the Columbia River. Umatilla was selected as a focus community because of navigation/transportation, recreational opportunities and sites, and irrigation.

History

Initially called Columbia, the town of Umatilla was founded in 1863 as a site for transferring gold on the Columbia River to the Walla Walla route. When mining declined, the town stagnated, but then grew into a local service center for increasing irrigated agricultural activity. The building of the Umatilla Army Depot in the 1940s and the McNary Dam in the 1950s contributed to a population boom. In 1963, a major portion of Umatilla was destroyed because of flooding caused by the John Day Dam, built 40 miles downriver.

7.3.2.7 Lewiston, Idaho

Lewiston is located in Nez Perce County at the confluence of the Clearwater and Snake rivers. Three major US highways in the region intersect in Lewiston and provide access to eastern Washington, northern Idaho, Montana. and southern Idaho. It was selected as a focus community for the following reasons: navigation at the Port of Lewiston (the only seaport in Idaho), recreational opportunities and access along the lower Snake River, construction impacts associated with implementation, and anadromous fish runs on the Snake and Clearwater rivers.

History

Founded in May 1861, Lewiston was the second permanent settlement in Idaho and the first incorporated town. Because of its location on the junction of the Snake and Clearwater rivers and seasonal navigation on the lower Snake River, Lewiston served as a supply center for regional mining operations. Following the gold boom, Lewiston continued to grow as a regional shopping, market, and distribution center for agricultural and timber operations. The Port of Lewiston was established in 1958. The Lewiston Orchards were annexed in 1969, doubling the town's area and population. The construction of the Lower Granite Dam in 1975 brought slackwater to Lewiston, making it the most inland port on the 460-mile Columbia-Snake River transportation system.

7.3.2.8 Orofino, Idaho

Orofino is located in Clearwater County, 45 miles upstream from the lower Snake River at the confluence of the Northfork and the Clearwater rivers. US 12, the major highway connecting Lewiston to Montana, passes through the middle of town. National Forests, wild and scenic rivers, the Dworshak Reservoir, and the Selway-Bitterroot Wilderness Area are close by.

Orofino was selected because of the anadromous fish runs on the Clearwater River, the sport fishing industry related to those runs, and the current conflict over flow augmentation from the Dworshak Reservoir that affects recreation, but that is required under the 1995 Biological Opinion. Orofino markets itself as the "Steelhead Capital of the World" and boasts the world's largest steelhead fish hatchery.

History

Orofino's history is centered on its natural resources. Gold prospectors first settled Orofino in 1861 and then demolished it when ore deposits were found beneath the town. Orofino was later rebuilt in a different location at the confluence of Orofino Creek and the Clearwater River. In 1889, the Northern Pacific Railroad began service to the town, and the first post office was established in 1897. Starting in the 1900s, wood production dominated the economy and continues to do so today. Orofino was incorporated in 1925. By 1940, it was an established center for white pine logging. Agriculture also grew. In 1962, the Lewis and Clark Highway was completed and was seen as a source of economic stimulation for tourism and commerce. In 1968, construction began on Dworshak Dam, contributing to population increases. Much of the population remained post-construction. Although timber production has declined over the past decade due to diminishing supplies of timber from National Forest lands, new opportunities in recreational tourism were created from the Clearwater River and the Dworshak Reservoir. The nation's largest steelhead

hatchery contributes to this tourism. The listing of Snake River salmon has negatively impacted these recreational developments.

7.3.2.9 Riggins, Idaho

Riggins is located in Idaho County, upstream from the lower Snake River along the Salmon River, a tributary to the Snake River. A major north-south highway (US 95) passes through the middle of town. Riggins was selected as a focus community because of the anadromous fish runs on the Salmon River, the recreational and sport fishing on the Salmon River, and the effects of listed salmon stocks on whitewater recreation.

History

The discovery of gold first attracted settlement in the Riggins area, which was officially named in 1908. Mining was replaced by livestock raising, which remained prominent until the 1950s. National Forests were established nearby. With the Civilian Conservation Corps (CCC) program of the 1930s, as well as other Federal projects, many roads, trails, fences, and water developments were established. During World War II, a sawmill was built, and logging became a dominant industry. The 1982 fire that destroyed the mill forced the community to rebuild their economy. The residents who stayed shifted to a recreation-based economy of fishing, river floating, and hunting, made possible by the resources of the Salmon River. In 1982, there was only one river outfitting company. Now, Riggins boasts 15, plus six motels, five restaurants, and three real estate agencies, among other services. The Salmon River Economic Development Association was formed in 1992 to assess the economic health of the area. Since its inception, many city improvements have occurred. Additionally, a medical clinic recently opened, the Goff Bridge has been replaced, and a new water system is being coordinated with the improvement of US 95.

7.4 Description and Comparison of Community Social Impacts

7.4.1 Comparison of Alternatives by Community

A major limitation to the evaluation of social impacts at the community level is the availability of information regarding the economic impact on key sectors in the study area. Although this study has described the impacts to farms at the county level, and the regional study team conducted a sensitivity impact analysis of decreased land under production, it is not possible to predict how many farms would be affected and the level of that impact on a given community. In addition, no information exists to forecast the employment impacts on other waterway shippers such as forest products and their linkages to other mills in northeastern Oregon and north central Idaho. Finally, who will pay for increased electrical rates, how they pay, and how much they will pay have not been defined, thus this analysis used a mid-point estimate where Federal beneficiaries of BPA power would pay the costs.

In the absence of this information, the discussion of community-level impacts should be considered as preliminary. Notwithstanding these limitations, the following discussion will illustrate who may be affected, how they may be affected, and how they may respond to changes in the operation of the four lower Snake River facilities. Although the impact matrix and evaluation of impacts are presented in Table 7-4 by resource change, the discussion will put these changes into the context of the four dimensions used for the description of the base case. These dimensions are jobs and wealth

(economics), place (character of the natural and built environment), vision and vitality (social organization and leadership), and people (demographic changes and effects on individual populations). Discussions of the community-level impacts include the direct and indirect impacts, as identified in this study and the other Corps' studies. References to employment include direct, indirect, and induced employment changes in the community. The focus community analysis conducted is supplemented by the perceptions of community members who participated in the community-based assessments conducted by the University of Idaho (for detailed methodology and findings see Harris, et al., 1999). Finally, the communities' prior experience with change events will place the identified impacts into an historical context.

7.4.1.1 Clarkston, Washington

The socioeconomic impacts of the three alternatives on the community of Clarkston could include changes in recreation activities, navigation/transportation, water supply, implementation, anadromous fish recovery, and costs of electrical power. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 affect the probability of anadromous fish recovery while having minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Clarkston. It would create both winners and losers through the loss of a navigable waterway, a shift in transportation modes, a change in recreational opportunities and access, an increased chance of anadromous fish recovery, and minor increases in power rates. In addition, the community could experience a dramatic short-term change in the character of the community as the reservoir is drained and a new shoreline is formed around the city. It is expected that Clarkston would realize short-term increases in implementation and municipal and industrial (M&I) water-supply, modification-related employment, as well as a temporary influx of outside workers. Overall, the community could experience both increases and decreases in employment, with a projected net gain in employment. Perhaps the most significant effect on the community could be the stranded social costs of planning and development activities structured around the continued existence of the four lower Snake River facilities and a navigable waterway.

Jobs and Wealth

Overall, Alternatives 2 and 3 provide a higher degree of certainty about the economic future of Clarkston. They do not adversely affect jobs and wealth directly, although the lower probability of salmon recovery may indirectly affect those businesses related to recreational fishing. Alternative 4 adversely affects future economic certainty and increases future economic risks, because not all of the indirect and induced effects of these changes are known. For example, it is unclear how the increased capital costs of pump and well modifications would affect local pulp and paper operations, the golf course, or irrigators along the Lower Granite pool.

Negative impacts on community employment from Alternative 4 could result from a reduction in county-wide farm income, loss of Corps-related jobs, loss of water-related port operations, loss of tour-boat-related employment, short-term decreased recreational opportunities, and increased residential electrical rates. Farmers and other shippers currently using the waterway to ship bulk products could experience increased costs to ship their goods. This might have a negative effect on employment in those economic sectors. Only Corps-related employment is projected to exceed a 1 percent decrease.

Positive impacts on community employment from Alternative 4 could result from increased truck transportation, post-implementation increases in river-recreation-related activities, increased anadromous fishing opportunities, road maintenance, and the short-term increases in employment from implementation activities and modifications to wells and water pumps.

The effects of these changes on the largest employers could demonstrate the degree to which there would be winners and losers in Clarkston. A wood products corporation, largest employer in the Lewiston-Clarkston valley, could be negatively affected by higher shipping costs for some of its products. On the other hand, asphalt companies could benefit from both the short-term construction-related implementation activities and the long-term road maintenance.

Place

Clarkston's natural and built environment could change dramatically under Alternative 4 much like it did 25 years ago when the pools were filled and orchards were inundated. Adverse impacts from the loss of the Lower Granite pool include the short-term exposure of shoreline and mudflats. The community could lose recreational access sites at Chief Lookinglass Park and Nisqually John Landing, as well as losing some recreational site services at Chief Timothy State Park, Hells Canyon Resort, Southway Park, and Hells Gate State Park. In addition, the community could have some short-term displacement from steelhead and salmon fishing, as well as displacement from other river-related recreation. The identity of the community as a working water port could also be adversely affected, although it would still retain its identity as a Snake River community and the gateway to Hells Canyon.

Another adverse effect of Alternative 4 could be an increase in truck traffic through the community and the county with a corresponding increased risk of traffic accidents. Additionally, the financial pressures exerted on local farmers from higher transportation costs may lead to a greater consolidation of farms and a change in the rural-urban interface of Clarkston.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River and the community shoreline. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon continue to exist, and local fishermen continue to pursue this element of the Clarkston's quality of life. Alternatives 2 and 3 have higher risks associated with salmon recovery and may, therefore, adversely affect the community's quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could all adversely affect Clarkston's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. Adverse effects of a change in the economic direction and identity of the community under Alternative 4 might include a pessimistic vision of not being able to control the community's future. The community has worked to develop recreational opportunities associated with the lower Snake River reservoirs, to bring tour boats from Portland into the community, to use the port as a development mechanism, and to develop retirement opportunities. Many of these plans could be significantly affected under this alternative. Additionally, the negative short- and long-term effects on both local and county property values and property tax revenue might create difficulties in

obtaining sufficient funding to pursue new avenues of economic development and maintain the current level of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The high number of fixed-income families may have to pay a larger proportion of their income to power bills. The growing elderly population in Clarkston might be physically unable to engage in the new recreational opportunities on a free-flowing lower Snake River. Finally, the influx of short-term, outside workers might disrupt traditional community patterns, although the number of forecast workers could be relatively small compared to the workforce that originally constructed the lower Snake facilities.

The forecast increase in long-term employment under Alternative 4 suggests that population trends should continue to increase. Given the uncertainties associated with the business climate, however, overall population might remain stable or decrease slightly given short-term job losses.

Historical Change Events and Potential Responses

Clarkston has a relatively high economic diversity and has undergone significant economic peaks and valleys over the past 25 years. During the construction of Lower Granite Dam and the dikes in the valley, unemployment was at an historical low. During the recession of the early 1980s, Asotin County lost over 1,200 jobs between 1980 and 1984. Clarkston has also experienced periodic layoffs in the wood manufacturing industry in the valley.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the changes in the human environment would be within historical bounds.

7.4.1.2 Colfax, Washington

The socioeconomic impacts of the three alternatives on the community of Colfax could include the effects of changed recreation activity, navigation/transportation, water supply, implementation, anadromous fish recovery, and power costs. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 affect the probability of anadromous fish recovery, while having minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Colfax. It could adversely affect the community primarily through the loss of a navigable waterway, a corresponding shift in transportation modes to more expensive rail and truck movements, a decrease in countywide net farm income, and a drop in property values for agricultural lands. It is expected that Colfax would realize short-term increases in implementation and well-modification-related employment, as well as a small temporary influx of outside workers. Overall, the community could experience both increases and decreases in employment, with a projected net loss in employment. The most significant effect on the community could be the additional financial pressures on grain farms from increased transportation, storage and handling costs, and uncertainty as to how the transportation system and individual farms would respond. The cumulative effects of Alternative 4 and the proposed phase-out of the loan deficiency payments under the Freedom to Farm Act could create even greater uncertainty for individual farmers and farm communities like Colfax.

Jobs and Wealth

Overall, Alternatives 2 and 3 would not adversely affect jobs and wealth directly. They could provide a higher degree of certainty about the economic future, although the degree of future regulatory oversight under these alternatives is unknown. Alternative 4 could adversely affect future economic certainty and increase future economic risks because not all of the indirect and induced effects of these changes are known. For example, it is unknown if some agricultural lands would go out of production or if none would go out of production, how many farm owners might be forced to sell, and how many would seek other employment.

Negative impacts on Colfax's employment from Alternative 4 could result from increased residential electrical rates, reduction in county-wide farm income, loss of Corps-related jobs, loss of water-related port operations, and short-term, decreased recreational opportunities. Farmers currently using the waterway to ship grains could experience increased costs to ship their goods. This could have a negative effect on farm income and further decrease jobs that support farm household expenditures. Total county farm income would probably decrease by at least 10 percent. The associated decrease in household spending would probably reduce employment in Colfax by more than 1 percent. With transportation, storage, and handling costs expected to increase an average of 17 cents per bushel for all grain production in the county, the value of agricultural land surrounding Colfax might be expected to fall by up to $140 per acre.

Positive impacts on community employment from Alternative 4 could result from an increase in truck and rail transportation employment, post-implementation increases in river recreation-related activities, increased anadromous fishing opportunities, and ongoing road maintenance. The increase in trucking- and rail-transportation-related employment might be higher than predicted by the allocation of employment impacts due to the large volumes of grain produced in the lands surrounding Colfax and the position of Colfax on the highway that would carry a large amount of the traffic. Short-term increases in employment could result from implementation activities, modifications to wells along the river, and upgrades to road and rail infrastructure.

Place

Colfax's natural and built environment may not change dramatically under Alternative 4. Changes would occur in the surrounding patterns of land ownership and in the access and recreational opportunities available on the nearby lower Snake River. Adverse impacts from the loss of the Lower Granite pool could include the loss of developed access at recreational sites such as Wawawai County Park, Ilia Dunes Landing, Willow Landing, Little Goose Landing, and Lyons Ferry Marina. Additionally, recreation services may diminish at sites such as Boyer Park and Marina, Central Ferry State Park, and Chief Timothy State Park. In addition, the community could experience short-term losses in recreational steelhead and salmon fishing and other river-related recreation as boat ramps are modified and the riverbank is revegetated. The identity of the community as agricultural may not be adversely affected by Alternative 4. The community should still continue to be the heart of the Palouse and a leader in wheat and lentil production.

Another adverse affect of Alternative 4 could be the financial pressures higher transportation costs would exert on local farmers. This might lead to a greater consolidation of farms and a decrease in the number of community members either directly or indirectly active in the farming industry. With or without a navigable waterway, Colfax would continue to be a transportation hub for the

movement of grain commodities produced in Whitman and neighboring counties. Truck traffic patterns could shift from a north-south to an east-west orientation with an estimated slight increase in overall traffic through town. This might be economically beneficial, but would increase congestion and impact safety through downtown and on Washington Route 26 westbound. Finally, Colfax could lose a river crossing at the Lower Granite facility. This crossing provides an alternative transportation corridor between Colfax and Pomeroy in Garfield County.

Long-term benefits of Alternative 4 could include the revegatation and restoration of the normative Snake River. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon would continue to exist and local fishermen would continue to pursue this element of the Colfax's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect this element of Colfax's quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could adversely affect Colfax's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The community has been united in its opposition to Alternative 4. Adverse effects of a change in the economic direction and identity of the community under Alternative 4 might challenge the leadership and vision of the community to provide a cost-effective way to transport the large volumes of grains to market. One key factor is the uncertainty about the capacity of alternative modes of transportation to handle the volume of production currently shipped on the lower Snake River.

The community has worked with the Port of Whitman County to develop successful industrial and shipping facilities. Some of these developments such as industrial parks sited away from the river may be unaffected by the change in the waterway, while other facilities on the river may become obsolete. Perhaps the most significant impact on the vision and vitality of the community would be the expected drop in property tax revenue both from agricultural and non-agricultural lands. The community could face raising tax rates or cutting social services. Neither of these choices is harmonious with the community's future plans and could limit investments in the economic diversification efforts. One ameliorating factor could be that property tax revenue would not change overnight, but rather would be phased in over a 5-year period of decreased farm income being capitalized into the land.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The poverty rate in Colfax is relatively low, as is the over-65 population; thus, large segments of the population may not be affected adversely by the increased electrical rates or the changes in slackwater recreation opportunities. Colfax might see a short-term influx of outside workers during the implementation, but this probably would not be a significant impact. The expected increased rate of land consolidation in the farm sector might contribute to a reduction in rural farm population.

Overall, the expected decrease in net employment under Alternative 4 suggests that community population would decrease slightly.

Historical Change Events and Potential Responses

Colfax's economy exhibits moderate economic diversity and has not experienced major economic peaks and valleys over the past 25 years, aside from the large cyclical swings in commodity prices and production yields. Community members have existed with the uncertainty associated with a farm-centered economy and lifestyle. Nevertheless, there is a strong cultural norm to make things work and build a future in this community.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community it appears that the changes in the human environment might exceed historical experience in this community.

7.4.1.3 Pomeroy, Washington

The socioeconomic impacts of the three alternatives on the community of Pomeroy could include the effects of changed recreation activity, navigation/transportation, water supply, implementation, anadromous fish recovery, and power costs. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 could affect the probability of anadromous fish recovery, while having a minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Pomeroy. It could adversely affect the community primarily through the loss of a navigable waterway, a corresponding shift in transportation modes to more expensive rail and truck movements, a decrease in countywide net farm income, and a drop in property values for agricultural lands. Pomeroy probably would realize short-term increases in implementation- and well-modification-related employment, as well as a significant temporary influx of outside workers. Overall, the community could experience both increases and decreases in employment, with a projected net loss in employment. The most significant effect on the community could be the additional financial pressures on grain farms from increased transportation, storage, and handling costs and the uncertainty as to how the transportation system and individual farms would respond. The cumulative effects of Alternative 4 and the proposed phase-out of the loan deficiency payments under the Freedom to Farm Act could create an even greater uncertainty to individual farmers and farm communities like Pomeroy.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a higher degree of certainty about the economic future. Alternative 4 could adversely affect future economic certainty and increase future economic risks because not all of the indirect and induced effects of these changes are known. For example, it is unknown if some agricultural lands would go out of production or, if none went out of production, how many farm owners might be forced to sell out and seek other employment.

Negative impacts on Pomeroy's employment from Alternative 4 could result from reduction in countywide farm income, loss of Corps-related jobs, increased residential electrical rates, and short-term decreased recreational opportunities. Farmers currently using the waterway to ship grains could experience increased costs to ship their goods. This could have a negative effect on farm income and further decrease jobs that support farm household expenditures. Total county farm income probably could decrease less than 10 percent. The change in direct, indirect, and induced

employment from a decrease in farm household spending probably would decrease employment in Pomeroy by less than 1 percent. With transportation, storage, and handling costs expected to increase an average of 7 cents per bushel of total grain production, the value of agricultural land surrounding Pomeroy might be expected to fall by up to $40 to $50 per acre.

Positive impacts on community employment from Alternative 4 could result from an increase in truck and rail transportation employment, post-implementation increases in river-recreation-related activities, increased anadromous fishing opportunities, and ongoing road maintenance. The increase in trucking- and rail transportation-related employment might be higher than predicted by the allocation of employment impacts. Both the large volumes of grain produced in the lands surrounding Pomeroy and the position of Pomeroy on the highway that could carry a large load of the traffic from Idaho counties to ports on the Columbia River indicate that Pomeroy would see higher levels of transportation-related employment. Short-term increases in employment could result from implementation activities, modifications to wells along the river, and upgrades to road infrastructure.

Place

Pomeroy's natural and built environment may not change dramatically under Alternative 4. Changes could occur in the surrounding patterns of land ownership and in the access and recreational opportunities available on the nearby lower Snake River. Adverse impacts from the loss of the Lower Granite pool could include the loss of developed access at recreational sites such as Wawawai County Park, Ilia Dunes Landing, Willow Landing, Little Goose Landing, and Lyons Ferry Marina. Access to Boyer Park and Marina by crossing the Lower Granite facility would be lost. Additionally, recreation services could be diminished at sites such as Boyer Park and Marina, Central Ferry State Park, and Chief Timothy State Park. The community may also experience short-term losses in recreational steelhead and salmon fishing and other river-related recreation, as boat ramps were modified and the riverbank was revegetated. The identity of the community as agricultural should not be adversely affected by Alternative 4.

Another adverse affect of Alternative 4 could be the financial pressures exerted on local farmers from higher transportation costs. This might lead to a greater consolidation of farms and a decrease in the number of community members either directly or indirectly active in the farming industry. Without a navigable waterway and access to the ports of Whitman and Garfield counties, Pomeroy would be on the major transportation route for the movement of grain and other commodities from Idaho and Asotin County. Truck traffic patterns may increase total vehicle traffic on US 12 through Pomeroy by more than 2 percent. This might be economically beneficial to roadside services, but would be adverse for congestion and safety through downtown and on US 12 westbound. Finally, Pomeroy could lose a river crossing at the Lower Granite facility. The crossing currently provides an alternative transportation corridor between Pomeroy and Colfax in Whitman County.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon would continue to exist and local fishermen would continue to pursue this element of Pomeroy's quality of life. Alternatives 2 and 3 would have higher risks associated with salmon recovery and might adversely affect this element of Pomeroy's quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could adversely affect Pomeroy's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. Changes in the economic direction and base of the community under Alternative 4 might challenge the leadership and vision of the community to provide cost-effective means of transporting the large volumes of grains to market since Pomeroy does not currently have rail access in the county. Additionally, leadership may be challenged to further enhance economic diversification efforts and to develop a recreational sector with a new type of tourism in mind.

Perhaps the most significant impact on the vision and vitality of the community may be the expected drop in property tax revenue both from agricultural and non-agricultural lands. The community could face raising tax rates or cutting social services. Neither of these choices is harmonious with the community's future plans and could limit investments in the economic diversification efforts. One ameliorating factor could be that property tax revenue would not change immediately but, rather, would be phased in over a 5-year period of decreased farm income.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The poverty rate in Pomeroy is relatively low, but Pomeroy has the highest median age and largest percentage of people over 65 in the study region. This retirement population could be adversely affected by loss of slack-water recreational opportunities on the lower Snake River.

Another significant impact for Pomeroy could be the short-term influx of outside workers during implementation. Pomeroy and Garfield County housed large numbers of outside workers during the construction of the last two lower Snake River facilities. The community and the county experienced the social stresses and economic boom associated with that activity. The level of workforce anticipated for the implementation of Alternative 4 is not expected to be as large or to extend over as long a period as the prior construction. These workers might, however, have different values and habits than the local residents and might cause short-term stress to the community.

Overall, the expected decrease in net employment under Alternative 4 indicates that community population could decrease slightly. In addition, the expected increased rate of land consolidation in the farm sector might contribute to further reduction in rural farm population and hinder attempts to keep young community members in the town.

Historical Change Events and Potential Responses

Pomeroy's economy exhibits moderate economic diversity and has experienced major economic peaks and valleys over the past 25 years including the boom and bust of the Lower Granite Dam construction and the large cyclical swings in the commodity prices and production yields. Community members have existed with the uncertainty associated with an agriculturally centered economy and lifestyle.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the changes in the human environment might not exceed historical experience in Pomeroy.

7.4.1.4 Kennewick, Washington

The socioeconomic impacts of the three alternatives on the community of Kennewick could include the indirect effects of irrigation, navigation/transportation, recreation activity, power costs, power production implementation, and anadromous fish recovery. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 affect the probability of anadromous fish recovery while having minimal effect on the physical or economic human environment. Alternative 4 could have minor direct effects on Kennewick but might have significant indirect effects since Kennewick is the retail and service center for the Tri-Cities and the surrounding region. The loss of Ice Harbor irrigated agriculture probably could produce the most significant impacts. Beneficial effects might come from siting new power plants, increased operations and maintenance employment, and related spending, as well as anadromous fish recovery. Increased transportation activity in the Tri-Cities, primarily Pasco, probably would also produce economic benefits for Kennewick.

Kennewick probably would realize short-term increases in implementation and power plant construction employment. Overall, the community could experience both increases and decreases in employment, with a projected net loss in employment. Perhaps the most significant effect on the community could be the loss of agricultural production due to the drawdown of the Ice Harbor pool and the uncertainty regarding the effect of those losses on the community economic structure. Aside from the specific physical and economic changes in Kennewick, a significant impact might be the fear that the successful breaching of the lower Snake River projects could jeopardize the future viability of the Columbia River waterway and the values it holds for Kennewick residents.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a higher degree of certainty about the economic future. Alternative 4 could adversely affect future economic certainty and could increase future economic risks because not all of the indirect and induced effects of these changes are known.

Negative indirect impacts on Kennewick's employment from Alternative 4 could primarily result from the loss of irrigated agriculture and increased residential electrical rates. The water supply analysis indicated that modifying the Ice Harbor pumps would cost more that the total land value or the value of the crops produced. The effect could be that Ice Harbor irrigated farm owners may not be able to make the necessary modifications and operations would cease. The effects of this economic loss to the region could indirectly impact the large service and retail sectors and, to a lesser degree, the agricultural service sectors in Kennewick. Losses are estimated at approximately 2 percent of total employment. The effects of increased residential electrical rates are estimated at below 1 percent. Total direct, indirect, and induced employment losses are estimated to be less than 2.5 percent of Kennewick's total employment.

Positive impacts on community employment from Alternative 4 could result from the operations and maintenance of new power plants in the region; increased trucking, rail, and barge transportation;

post-implementation increases in river recreation-related activities; and road maintenance. Short-term increases in employment could result from power plant construction, transportation infrastructure upgrades, and implementation activities. The long-term gains could probably be less than a 1 percent increase in Kennewick's total employment.

The positive and negative effects of these employment changes may be felt primarily in the service and retail and wholesale trade sectors. It does not appear that any one business or service would be disproportionately affected. Overall, the most significant effect of Alternative 4 could be the heightened uncertainty about the fate of the Columbia River.

Place

Kennewick's natural and built environment may not change significantly under Alternative 4. Adverse impacts from the breaching of the four lower Snake River facilities could eliminate nearby developed recreational access sites such as the North Shore Ramp, Ayer Boat Basin, and Lyons Ferry Marina. Kennewick may also lose some developed recreational site services at Charboneau Park, Levy Landing, Fishook Park, and Windust Park. Although this represents a small fraction of the recreational slack water recreational sites in the region, a more significant impact might be the short-term crowding at Columbia River sites from lower Snake River displaced recreationists. The identity of the community as a riverside retail and service urban center may not be affected adversely by this alternative.

Another indirect effect on Kennewick's place could be the increased traffic into the Tri-Cities. Traffic increases probably would not occur in the city of Kennewick, but could occur across the Columbia River in Pasco. Overall traffic volumes on highways from eastern Washington feeding into the Tri-Cities probably could increase between 2 and 6 percent. Some of this traffic might alter movement patterns by Kennewick commuters and might provide additional employment and income to Kennewick.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River and the shoreline. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon would continue to exist, and local fishermen would continue to pursue this element of the Kennewick's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect the community's future quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could all adversely affect Kennewick's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The Chamber of Commerce has issued a position paper on the breaching of the lower Snake River facilities and has joined in rallies to save the dams. One significant impact on the vision and vitality of Kennewick of each of the alternatives, but primarily from Alternative 4, could be the fear that successfully breaching the dams or the continued listing of the salmon and steelhead as endangered would lead to the eventual breaching of the Columbia River facilities. The proposed alternatives of this study are seen as a first step to the removal of dams that provide the navigable waterway and recreational benefits to the community. Kennewick has been actively developing its waterfront, green areas, and Clover Island, and the fear of future loss of its waterfront represents a significant effect of each of the study's alternatives.

People

Changes in the physical and economic human environment could affect distinct populations in the community. Benton County has been designated as an economically distressed area and has a high level of poverty. More than 10 percent of the families are classified as below the poverty line. Families on low or fixed incomes may have to spend a larger portion of their income on electrical bills. The forecast decrease in net long-term employment under Alternative 4 signifies that population trends might not continue to increase at current or historical rates, although the community's thriving economy probably could continue to grow and attract new community members.

Historical Change Events and Potential Responses

Kennewick's economy exhibits high economic diversity and has experienced major economic peaks and valleys over the past 25 years. These trends are associated primarily with activities at the Hanford Reservation. Community members have existed with the uncertainty associated with the level of government activity on the reservation and have built a strong, retail-based community around that uncertainty. In the 1980s, suspension of work on the WPPSS facilities resulted in a loss of 15,000 jobs in the Tri-Cities area. During the 1990s, the Tri-Cities have lost an estimated 6,700 jobs since peaking in 1994. Approximately 1,000 jobs per year have been associated with Hanford workplace reductions. During this recent downturn, the community has not lost population, and school enrollment has continued to grow.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the changes in the human environment would not exceed historical experiences in Kennewick.

7.4.1.5 Pasco, Washington

The socioeconomic impacts of the three alternatives on the community of Pasco could include the effects of irrigation, navigation/transportation, recreation activity, power costs, implementation, and anadromous fish recovery. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 affect the probability of anadromous fish recovery, while having a minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in and around Pasco. It could create both winners and losers through the shift in transportation modes and nodes, changes in recreational opportunities and access, lost irrigation acreage and employment, construction and operation of new power plants, loss of power produced at the four projects, and an increased chance of anadromous fish recovery.

Additionally, the community could experience a dramatic short-term change in the character of the community as grain from eastern Washington, Idaho, Montana, and North Dakota shipped on the lower Snake River is rerouted into the Pasco port and through the Pasco rail yards. It is expected that Pasco could realize short-term increases in implementation and power plant construction employment. Overall, the community could experience both increases and decreases in employment, with a projected net loss in employment. Perhaps the most significant effect on the community could be the loss of agricultural production on the Ice Harbor Reservoir and the uncertainty of those losses on the community economic structure. Aside from the specific physical and economic changes in Pasco, a significant impact might be the fear that a successful breaching of

the lower Snake River facilities could jeopardize the future viability of the Columbia River waterway.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a higher degree of certainty about the economic future. Alternative 4 could adversely affect future economic certainty and increase future economic risks because all of the indirect and induced effects of these changes are not known. For example, it is unclear how the loss of irrigated agricultural production from Ice Harbor Reservoir may affect the growing food processing facilities in Pasco or how displaced agricultural workers would adapt to lost employment.

Negative impacts on Pasco employment from Alternative 4 could result from the loss of irrigated agriculture, higher residential electrical rates, reduction in countywide farm income, and a loss of Corps- related jobs. The water supply analysis indicated that modifying the Ice Harbor pumps could cost more than the total land value or the value of the crops produced. Ice Harbor irrigated farm owners may not be able to make the necessary modifications and operations could cease. Approximately 20 percent of the land is located in Franklin County, and much of the agricultural service sector that supplies these farms could be affected. The direct, indirect, and induced employment losses in Pasco in just the agriculture/agricultural services sector are estimated to be approximately 9 percent of the agricultural sector, although the total loss of employment from this change is estimated to be less than 2.5 percent of Pasco's total employment. None of the other negative employment effects decreases employment by more than 1 percent. Total direct, indirect, and induced employment losses are estimated to be less than 2.5 percent of Pasco's total employment.

Positive impacts on community employment from Alternative 4 could result from increased trucking, rail, and barge transportation, post-implementation increases in river-recreation-related activities; road maintenance, short-term increases in employment from power plant construction, transportation infrastructure upgrades, implementation activities; and modifications to lower Snake River wells. With Pasco becoming the closest port to eastern Washington and Idaho grain production, significant quantities of grain are forecast to move through the port rail and barge facilities. In effect, Pasco could receive a high percentage of the jobs lost by Lewiston, Clarkston, and the other lower Snake River water port operations. These gains are estimated to be less than a 1 percent increase in Pasco's total employment.

The effects of these employment changes on the largest employers in the community demonstrate the degree to which there will be winners, losers, and uncertain futures associated with Alternative 4. Local manufacturing operations depend to an unknown degree upon fiber plantations along the Ice Harbor Reservoir. The loss of these plantations could place financial pressure on their operations, and a long-term investment could be stranded. Railroads, on the other hand, could stand to gain or capture traffic volume as farmers and other shippers searched for cost-effective means to ship their products to Portland. Finally, food processing plants could have a diminished source of primary product for food processing activities. The degree to which a decreased supply of agricultural products could affect employment is unknown.

Place

Pasco's natural and built environment may not change significantly under Alternative 4. Adverse impacts from the breaching of the four lower Snake River facilities could eliminate developed recreational access sites such as the North Shore Ramp, Ayer Boat Basin, and Lyons Ferry Marina. Pasco could also lose some developed recreational site services at Charboneau Park, Levy Landing, Fishook Park, and Windust Park. Although this represents a small fraction of the slack water recreational sites in the region, a more significant impact might be the short-term crowding from lower Snake River displaced recreationists. The identity of the community as a riverside transportation and agricultural urban center may not be adversely affected by this alternative.

The most significant change could be the increased truck traffic into the ports. Increased truck traffic could converge from Interstate 395, US 12, and SR 124 into the port facilities. Truck traffic into the city from the north probably would rise between 6 and 21 percent above current truck traffic volumes. Overall vehicle traffic is expected to increase between 2 and 6 percent. Although this traffic represents an economic benefit to the community, it might congest the feeder streets to the port facilities and increase the safety risk within and outside of the city. This added traffic could also have a negative impact on the condition of city streets.

Long-term benefits of Alternative 4 could include revegetation and restoration of the normative Snake River and the shoreline. Additionally, the increase salmon would benefit the identity of the community as a place where salmon would continue to exist and local fishermen would continue to pursue this element of Pasco's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect the community's future quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could all affect Pasco's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The Chamber of Commerce has issued a position paper on the breaching of the lower Snake River facilities and has joined in rallies to save the dams. One significant impact on the vision and vitality of Pasco for each of the alternatives, but primarily for Alternative 4, could be the fear that successfully breaching the dams or the continued listing of the salmon and steelhead as endangered could lead to the eventual breaching of the Columbia River facilities. The proposed alternatives of this study are seen as a first step to the removal of the Columbia River dams that provide the navigable waterway and recreational benefits to the community. Alternative 4 might seriously challenge the leadership and vision of the community as community members work to address the large numbers of displaced full-time and seasonal workers from the irrigated lands on Ice Harbor. The community has worked to successfully develop the facilities at the Port of Pasco and to diversify the local economy by developing value-added food processing centers to the economic structure of Pasco. These plans and achievements might be affected adversely under this alternative.

Finally, the negative short- and long-term effects of lost agricultural production on both local and county property values and property tax revenue might create difficulties in obtaining enough funding to pursue new avenues of economic development and to maintain the current and anticipated increased levels of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community. Franklin County has been designated as an economically distressed area and has a high level of poverty. More than 10 percent of families are classified as below the poverty line, and these numbers might increase with the loss of employment on the Ice Harbor irrigated lands. These families on low or fixed incomes could have to spend a larger portion of their income on electrical bills. In addition, farm workers displaced from the Ice Harbor lands are primarily Hispanic, and Pasco's population is more than 40 percent Hispanic. The concerns related to the disproportional negative impacts of this alternative are addressed in the EIS's environmental justice discussion.

The forecast decrease in net long-term employment under Alternative 4 signifies that population trends might not continue to increase at current or historical rates.

Historical Change Events and Potential Responses

Pasco's economy exhibits high economic diversity and has experienced major economic peaks and valleys over the past 25 years. These changes are associated primarily with activities at the Hanford Reservation and the fortunes of agriculture. Community members have existed with the uncertainty associated with the level of government activity on the reservation and have built upon a strong transportation and agricultural base. Pasco has not been as directly affected by the benefits of the Hanford Reservation; nonetheless, some of the 15,000 jobs lost in the 1980s did occur in Pasco. More recently, the Tri-Cities have lost an estimated 6,700 jobs since peaking in 1994. Approximately 1,000 jobs per year have been associated with Hanford workplace reductions. During this recent downturn, the community has not experienced population declines, and school enrollment has continued to grow.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, changes in the human environment probably would not exceed historical experiences in Pasco. The direct effects on the agricultural sector might, however, be more significant than previous experiences in the absence of mitigation.

7.4.1.6 Umatilla, Oregon

The socioeconomic impacts of the three alternatives on the community of Umatilla could include the effects of irrigation, navigation/transportation, recreation activity, power costs, power production, implementation, and anadromous fish recovery. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 may affect the probability of anadromous fish recovery while having minimal effects on the physical or economic human environment. Alternative 4 could affect Umatilla through the siting of power plants to replace the lost hydroelectric power generated by the four lower Snake River facilities. The loss of Ice Harbor irrigated agriculture might adversely affect Umatilla food processors who obtain a small portion of their product from the Ice Harbor farms. Beneficial economic impacts might result from siting new power plants in the region and the associated increased operations and maintenance employment and related spending. Although not predicted in the Corps transportation model, the Port of Umatilla might experience increased activity due to the presence of grain-loading facilities and the projected shortages of these facilities in the Tri-Cities area. Overall, the community could experience both

increases and decreases in employment, with a small projected net loss in employment. This net loss might change to a significant net increase if the replacement power plants were sited in Umatilla or nearby. Aside from the expected physical and economic changes in Umatilla, a significant impact might be the fear that the successful breaching of the lower Snake River facilities could jeopardize the future viability of the Columbia River Waterway and in particular the John Day dam.

Jobs and Wealth

Overall, Alternatives 2 and 3 may have a higher degree of certainty about the economic future and may not adversely affect jobs and wealth directly. Alternative 4 could adversely affect future economic certainty and would increase future economic risks because not all of the indirect and induced effects of these changes are known.

Negative indirect impacts on Umatilla's employment from Alternative 4 could result from the loss of Ice Harbor irrigated agriculture and increased residential electrical rates. The water supply analysis indicated that modifying the Ice Harbor pumps could cost more that the total land value or the value of the crops produced. The effect could be that Ice Harbor irrigated farm owners would be unable to make the necessary modifications and operations would cease. The effects of this economic loss to the region could indirectly impact the agricultural and food-processing sectors in Umatilla. The magnitude of these effects on the food-processing sector are unknown. Sediment from the lower Snake River probably would not adversely affect irrigators out of the John Day pool. Overall employment losses are estimated to be approximately 1 percent of total employment. The effects of increased residential electrical rates are estimated at below 1 percent.

Positive impacts on community employment from Alternative 4 could result from the operation and maintenance of new power plants in the region. Short-term increases in employment could result from power plant construction, transportation infrastructure upgrades, recreation activities, and implementation. The long-term gains probably may be less than a 1 percent increase in Umatilla's total employment, but might be significantly higher if the new power plants were to be sited in the Hermiston/Umatilla/Bordman area. Total net employment changes are estimated to be less than a 1 percent decrease.

Overall, the most significant economic effect of Alternative 4 could be the heightened uncertainty about the fate of the Columbia River and the local irrigated agriculture that depends on river water.

Place

Umatilla's natural and built environment may not change significantly under Alternative 4 unless the new power plants were sited close to the community. It is beyond the scope of this report to analyze the effects of a proposed power plant, but adequate environmental and socioeconomic assessments would be required. Adverse impacts on recreation sites within 50 miles of Umatilla could include the elimination of the North Shore Ramp. Umatilla could also lose some developed recreational site services at Charboneau Park, Levy Landing, and Fishook Park. Although this represents a small fraction of the slack water recreational sites in the region, a more significant impact might be the short-term crowding at Columbia River sites from lower Snake River displaced recreationists. The identity of the community as the Walleye capital of the world would not be adversely affected by this alternative.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River and the shoreline. Additionally, the increase salmon would benefit the identity of the community as a place where salmon would continue to exist, and local fishermen would continue to pursue this element of Umatilla's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect future community quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could all adversely affect Umatilla's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. One significant impact on the vision and vitality of Umatilla of each of the alternatives, but primarily Alternative 4, could be the fear that successfully breaching the dams or the continued listing of the salmon and steelhead as endangered could lead to the eventual breaching of the Columbia River facilities. The proposed alternatives of this study are seen by community members as a first step to the removal of dams that provide the navigable waterway and recreational benefits to the community.

If the replacement power plants were sited near Umatilla or within Umatilla County, the community might achieve increased tax revenues to support essential county and community services.

People

Changes in the physical and economic human environment could affect distinct populations in Umatilla. A relatively high level of poverty exists for families in Umatilla, and these families could be expected to expend a larger of their income on increased electrical bills. The small forecast decrease in net long-term employment under Alternative 4 signifies that population trends might not continue to increase at current or historical rates. It is likely that in both the short- and the long-term, population could increase if the replacement power plants were sited close to the community.

Historical Change Events and Potential Responses

Umatilla's economy exhibits moderately high economic diversity and has experienced the cyclical flows associated with agriculture and food manufacturing. Irrigated agriculture expanded rapidly in the 1970s and 1980s. Recent years have seen a minor downturn in the food processing/ manufacturing industries.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the minor changes in the human environment could not exceed historical experiences in Umatilla.

7.4.1.7 Lewiston, Idaho

The socioeconomic impacts of the three alternatives on the community of Lewiston could include the effects of changed recreation activities, navigation and transportation, M&I water supply, implementation, anadromous fish recovery, and power costs. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 could affect the probability of anadromous fish recovery, while having a minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on the specific populations of

Lewiston. It could create both winners and losers through the loss of a navigable waterway, loss of power produced at the four projects, a shift in transportation modes, a change in recreational opportunities and access, and an increased chance of anadromous fish recovery. In addition, the community could experience a dramatic short-term change in the character of the community as the reservoir was drained and a new shoreline was formed around the city with the existing levees left high above the new water line. It is expected that Lewiston could realize short-term increases in implementation and M&I water supply modification-related employment, as well as a temporary influx of outside workers. Overall, the community could experience both increases and decreases in employment, with a projected net gain in employment. Perhaps the most significant effect on the community could be the stranded social energy and costs of developing activities and plans centered around the continued existence of the four lower Snake River facilities, a navigable waterway, and an inland port.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could have a higher degree of certainty about the economic future. Alternative 4 could adversely affect future economic certainty and increase future economic risks because not all of the indirect and induced effects of these changes are known. For example, it is unclear how the increased capital costs of pump and well modifications could affect local pulp and paper operations, the golf course, or local rock processors.

Negative impacts on Lewiston employment from Alternative 4 could result from a reduction in county-wide farm income, loss of Corps-related jobs, loss of water-related port operations, loss of tour boat-related employment, short-term decreased recreational opportunities, and an increase in residential electrical rates. Farmers and other shippers currently using the waterway to ship bulk products could experience increased costs to ship their goods. This might have a negative effect on employment in those and related economic sectors. None of the changes in the resource areas studied is projected to decrease employment in Lewiston by more than 1 percent.

Positive impacts on community employment from Alternative 4 could result from trucking transportation, post-implementation increases in river recreation-related activities, increased anadromous fishing opportunities, road maintenance, short-term increases in employment from implementation activities, and modifications to water pumps.

The potential effects of these changes on the largest employer, a local pulp and paper plant, demonstrate the degree of economic uncertainty associated with Alternative 4. It could be negatively affected by higher shipping costs for some of its products and by requirements to modify effluent and water intake systems. It is unknown how it would respond to these increased operational and capital costs, but these costs probably could be passed on to consumers.

Place

Lewiston's natural and built environment could change dramatically under Alternative 4, much like it did 25 years ago when the levees were built, the Lower Granite pool filled, and slackwater reached Lewiston. Adverse impacts from the loss of the Lower Granite pool could include the short-term exposure of shoreline and mudflats and the isolation of the levee parks from the water. The community could lose recreational access sites at Chief Lookinglass Park and Nisqually John

Landing, as well as some recreational site services at Chief Timothy State Park, Hells Canyon Resort, Swallows Park, Clearwater Ramp, Southway Park, and Hells Gate State Park. In addition, the community could experience short-term losses in recreational steelhead and salmon fishing and other river-related recreation. The identity of the community as a working water port and the only inland water port in Idaho could also be adversely affected, although it could still retain its identity as a Snake River community surrounded by extensive natural features.

Another adverse affect of Alternative 4 could be the financial pressures exerted on local farmers from higher transportation costs. This might lead to a greater consolidation of farms and a change in the agricultural-urban identity of Lewiston.

Long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River and the community shoreline. Additionally, the increase of salmon would benefit the identity of the community as a place where salmon would continue to exist and local fishermen would continue to pursue this element of Lewiston's quality of life. Alternatives 2 and 3 could have higher risks associated with salmon recovery and might adversely affect future community quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 all could adversely affect Lewiston's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The city council has debated the issue and been split in its position. Adverse effects of a change in the economic direction and identity of the community under Alternative 4 might seriously challenge the leadership and vision of the community. The community has worked successfully to develop the facilities at the Port of Lewiston and to diversify the local economy by enhancing recreational opportunities associated with the lower Snake River pools, Hells Canyon, and surrounding natural areas. They have also successfully developed green areas along the waterway, providing local recreational opportunities. The port serves as a vehicle for manufacturing and industrial growth through its industrial properties and loading facilities. Many of these plans and achievements could be significantly affected under this alternative. The Port of Lewiston is in a good position to continue to act as a development mechanism, using both rail and highway access, but this is not the current direction of the port's activities. Additionally, the negative short- and long-term effects on both local and county property values and property tax revenue might make it difficult to obtain enough funding to pursue new avenues of economic development and maintain the current level of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community, although not to the degree seen in Clarkston. Families, including those on fixed incomes, could have to pay a larger proportion of their income to power bills. In addition, the influx of short-term outside workers might disrupt traditional community patterns, although the number of forecast workers is relatively small compared to the workforce required to construct the lower Snake River facilities.

The forecast increase in long-term employment under Alternative 4 signifies that population trends should continue to increase. Given the uncertainties associated with the business climate, however,

overall population might remain stable or decrease slightly given short-term job losses and uncertain responses from businesses.

Historical Change Events and Potential Responses

Lewiston has a relatively high economic diversity and has undergone significant economic peaks and valleys over the past 25 years. During the construction of Lower Granite Dam and the Lewiston/Clarkston dikes, the valley unemployment was at an historical low. Lewiston lost over 1,000 jobs between 1981 and 1982. More recently, Nez Perce County lost approximately 300 manufacturing jobs between 1990 and 1991 and from 1994 to 1995.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community it appears that the changes in the human environment would be within historical bounds.

7.4.1.8 Orofino, Idaho

The socioeconomic impacts of the three alternatives on the community of Orofino could include the effects of power costs, recreation activity, navigation and transportation, M&I water supply, implementation, and anadromous fish recovery. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 could affect the probability of anadromous fish recovery, while having a minimal effect on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Orofino. It could create both winners and losers through an increased chance of anadromous fish recovery, a change in recreational opportunities and access, loss of a navigable waterway, loss of power produced at the four projects, and a shift in transportation modes. It is expected that Orofino could realize short-term increases in implementation, infrastructure improvements, and M&I water supply modification-related employment. Overall, the community could experience both increases and decreases in employment, with a projected net gain in employment. Perhaps the most significant effect on the community could be from the increased chance of wild salmon and steelhead runs on the Clearwater River and the enhanced status of Orofino as "Steelhead Capital of the World."

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a lower degree of certainty about the economic future. It is not anticipated that these alternatives would significantly improve fish returns; therefore, the planned development of the tourism sector of the economy might not grow as anticipated. Alternative 4 could adversely affect future economic certainty in the forestry and agricultural sectors and could increase future economic risks because not all of the indirect and induced effects of these changes are known. For example, it is unclear how the increased transportation costs would affect the timber industry's ability to sell wood chips or whether this increased cost would decrease the already unstable timber industry in Orofino. Alternative 4 could beneficially affect the future economic certainty of the tourism sector.

Negative impacts on community employment from Alternative 4 could result from increased transportation costs, reduction in countywide farm income, residential electrical rates, loss of Corps-related jobs, and short-term decreased recreational opportunities. Farmers and other shippers currently using the waterway to ship bulk products could experience increased costs to ship their

goods. This could have a negative effect on employment in those economic sectors. A small volume of grain currently moves from Clearwater County on the lower Snake River while a larger volume of wood products move to Lewiston for eventual shipment down the waterway. These decreases are not expected to be larger than 1 percent, although the magnitude of the effect on forest product manufacturers is unknown.

Positive impacts on community employment from Alternative 4 could result from increased truck transportation, increased anadromous fishing opportunities, and the short-term increases in employment from implementation activities and modifications to water pumps. The projected increases in wild fish returns after 20 years probably would increase employment by approximately 2 percent. Given the established sport fishing industry and strong retail trade sector in Orofino, the magnitude of this increase might be much greater given the potential future fish harvests.

Lumber companies are two of the largest employers in Orofino. The effects of increased transportation costs are unknown, but the increased financial obligations might adversely affect these employers.

Place

Orofino's natural and built environment may not be significantly changed under Alternatives 2, 3, and 4. Flow augmentation water currently withdrawn from the Dworshak Reservoir would continue under each of the proposed alternatives and would have negative effects on the local reservoir recreational opportunities and reservoir tourism. The loss of the Lower Granite pool could adversely affect the community's access to recreation sites on the lower Snake River within 50 miles of Orofino. The community could lose recreational access sites, including Chief Lookinglass Park and Nisqually John Landing, as well as some recreational site services at Chief Timothy State Park, Hells Canyon Resort, Southway Park, and Hells Gate State Park. The short-term displacement of Snake River recreationists might create crowding on the Dworshak Reservoir and at sites on the Clearwater River. This might also provide a short-term economic benefit to the community. Finally, the financial pressures exerted on local farmers from higher transportation costs might lead to a greater consolidation of farms and a change in the rural land-use patterns around Orofino.

One long-term benefit of Alternative 4 could be the decrease in truck traffic along US 12 as grains from Montana and North Dakota moved to new transportation corridors. This could have a positive effect of lessening traffic congestion and improving highway safety, but it might also decrease the existing economic benefits of truck traffic.

Other long-term benefits of Alternative 4 could include the revegetation and restoration of the normative Snake River. Additionally, the increase of salmon would benefit the identity of the community as a place where wild salmon would continue to exist and local fishermen would continue to pursue this element of Orofino's quality of life. Alternatives 2 and 3 have higher risks associated with salmon recovery and might adversely community quality of life. The identity of the community as the Steelhead Capital of the World would be enhanced by Alternative 4 and adversely affected by alternatives 2 and 3.

Vision and Vitality

Alternatives 2, 3 and 4 all adversely affect Orofino's vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. In addition, all of the alternatives could continue with flow augmentation over the protests of Orofino residents. The community has worked to develop recreation and tourism alternatives in steelhead fishing and reservoir recreation to diversify its predominately timber-dependent economy. Those plans specific to the Dworshak Reservoir could continue to be affected adversely by continued flow augmentation. Alternatives 2 and 3 could adversely affect development for the steelhead fishery and sportfishing industries. Alternative 4 could provide support these development efforts. Additionally, the negative effects of decreased farm income on both local and county property values and property tax revenue might create difficulties in obtaining sufficient funding to pursue new avenues of economic development and maintain the current level of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The high number of fixed-income families could have to pay a larger proportion of their income for power bills.

The forecast increase in long-term employment under Alternative 4 suggests that recent population trends should continue to increase but, given the 10- to 20-year horizon for increased salmon populations, population might increase slightly.

Historical Change Events and Potential Responses

Orofino has a relatively high economic diversity and has undergone significant economic shifts over the past 25 years. During the construction of Dworshak Dam, employment boomed. Throughout the 1980s and 1990s, the historically important timber industry experienced continuing employment decreases. Between 1980 and 1990, the population of Orofino shrunk by almost one-quarter or 1,000 people, primarily due to downturns in the timber industry.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community it appears that the minor changes in the human environment could be within historical bounds.

7.4.1.9 Riggins, Idaho

The socioeconomic impacts of the three alternatives on the community of Riggins could include the effects of changed recreation activity, navigation and transportation, anadromous fish recovery, and power costs. Table 7-4 presents a matrix of the various impacts and the effects of the proposed alternatives. Alternatives 2 and 3 could affect the probability of anadromous fish recovery, while having negative indirect effects on the physical or economic human environment. Alternative 4 could have significant effects on specific populations in Riggins and could create both winners and losers through an increased chance of anadromous fish recovery, a change in recreational opportunities and access, the loss of a navigable waterway, the loss of power produced at the four projects, and a shift in transportation modes. Overall, the community could experience both

increases and decreases in employment, with a projected net gain in employment. Perhaps the most significant effect on the community could be the increased chance of wild salmon and steelhead runs on the Salmon River and the potential economic benefits of increased sportfishing.

Jobs and Wealth

Overall, Alternatives 2 and 3 may not adversely affect jobs and wealth directly and could provide a higher degree of certainty about the economic future. It is not anticipated that these alternatives would significantly improve fish returns; therefore, the planned development of the tourism sector of the economy might not grow as anticipated. While Alternative 4 could adversely affect future economic certainty and the health of the agricultural sector, it probably would beneficially affect the future economic certainty of the tourism sector.

Negative impacts on community employment from Alternative 4 could result from increased transportation costs, reduction in countywide farm income, and increased residential electrical rates. Farmers in the county currently using the waterway to move grains would experience increased transportation costs. This might have a negative effect on employment. A large volume of grain currently moves from Idaho County on the lower Snake River, and the county's farmers are expected to see the highest increase in shipping costs in the region. The reduction in total county farm income probably could be greater than 10 percent. These are significant impacts for the grain-producing regions of Idaho County on the Camas Prairie, but are not expected to significantly affect the economy of Riggins. Decreases in employment are expected to be less than 1 percent.

Positive impacts on community employment from Alternative 4 could result from increased anadromous fishing opportunities. The projected increases in wild fish returns after 20 years probably could increase employment by approximately 1 percent. Given the established sport fishing industry and the strong retail trade and service sectors in Riggins, the magnitude of this increase might be much greater given the potential future fish harvests.

Place

Riggins' natural and built environment may not be significantly changed under Alternatives 2, 3, and 4. The short-term displacement of lower Snake River recreationists might create crowding at sites on the Salmon River. This might provide a short-term economic benefit to the community. The financial pressures exerted on local farmers from higher transportation costs might lead to a greater consolidation of farms and a change in the rural land-use patterns around Riggins.

One long-term benefit of Alternative 4 could be the decrease in truck traffic along US 95 as grains from Southern Idaho moved to new transportation corridors. This could have the positive effect of lessening traffic congestion and improving highway safety, but it might also decrease the existing economic benefits of through traffic.

Another long-term benefit of Alternative 4 could be the increased chance of salmon recovery. This could benefit the identity of the community as a place where wild salmon would continue to exist and local fishermen would continue to pursue this element of Riggins' quality of life. Alternatives 2 and 3 would have higher risks associated with salmon recovery and might adversely community quality of life.

Vision and Vitality

Alternatives 2, 3, and 4 could affect Riggins' vision and vitality by decreasing the social cohesion of the community over the issue of salmon recovery and the best way to achieve that goal. The community has worked to develop recreation and tourism alternatives in steelhead fishing and whitewater rafting after the community sawmill burned down. Alternatives 2 and 3 could adversely affect the development of tourism related to anadromous fish. Alternative 4 could provide support for these development efforts. Additionally, the negative effects of decreased farm income on both local and county property values and property tax revenue might create difficulties in obtaining sufficient funding to pursue new avenues of economic development and maintain the current level of community services.

People

Changes in the physical and economic human environment could affect distinct populations in the community. The high number of fixed-income families could have to pay a larger proportion of their income to power bills.

The forecast increase in long-term employment under Alternative 4 suggests that recent population trends could continue to increase, but given the 10- to 20-year horizon for increased salmon populations, population might increase slightly in the interim.

Historical Change Events and Potential Responses

Riggins has moderate economic diversity and has undergone significant economic shifts over the past 25 years. The loss of the sawmill, the towns largest employeer in 1982, was the most significant shift. The community relies on the seasonal and cyclical nature of the travel and tourism industry; thus it faces some economic uncertainty.

Given the estimated impacts described above, the historical adaptation to economic and physical changes in the community, and the current economic diversity of the community, it appears that the minor changes in the human environment are within historical bounds.

7.5 Mitigation Analysis

7.5.1 Compensation Potential

The employment impacts identified in the regional analysis could be addressed by providing targeted job retraining and education credits to dislocated workers. The effects on net farm income due to increased transportation costs could be mitigated through a program similar to the Conservation Reserve Program, whereby farmers would receive compensation equal to the transportation cost increases.

Community-level impacts could be addressed by providing block grants to affected communities in the region for economic diversification activities. For example, to mitigate farm communities most affected by the loss of river transportation, economic development programs similar to those mentioned above could be used to create more local value-added products and decrease dependency on the export of unprocessed grains to foreign markets.

Under Alternative 2, the lower probability of and the higher degree of risk associated with anadromous fish recovery, negative economic and social impacts to sport-fishing-dependent communities could develop. These communities might lose an important component of their economic base and might need assistance to transition to another non-fishery-dependent job base.

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8. Risk and Uncertainty

8.1 Introduction

This section presents the risk and uncertainty assessment of economic and social analyses developed for the lower Snake River Juvenile Salmon Migration Feasibility Study. This feasibility study may affect decisions about environmental and economic values that people care about and want to protect. As such, it is important to consider the reliability of its findings. That is the purpose of this risk and uncertainty assessment. The overall conclusion of the risk and uncertainty assessment, in its most succinct form, is that unresolved social and economic issues do cause uncertainty about whether it would be more cost-effective to breach the four lower Snake River dams. At this point, the driving uncertainties include:

- The value of future recreational and passive use benefits if the dams are breached
- The future of anadromous fish stocks
- How social and economic costs will be distributed

Other economic uncertainties, although important, are unlikely to affect decisions about whether it would be more cost-effective to breach the four lower Snake River dams.

How best to assess risks and uncertainties in studies of natural resources management options is a difficult question to answer. Ignoring uncertainties can lead to bad decisions, but considering them can slow down the decision-making process. Two of the best references on the topic are *Confronting Uncertainty in Risk Management: A Guide for Decision Makers* (Finkel, 1990) and *Uncertainty: A Guide to Dealing with Uncertainty in Quantitative Risk and Policy Analysis* (Morgan *et al.*, 1990). Both advocate uncertainty analysis, but warn against "paralysis by analysis." A classic paper on right and wrong ways for dealing with uncertainty in making risk management decisions is "Witches, Floods and Wonder Drugs: Historical Perspectives on Risk Management" (Clark, 1980). A compilation of classic papers on making risk management decisions under uncertainty can be found in the Resources for the Future book *Readings in Risk* (Glickman and Gough, 1990). Finally, a more recent and somewhat more technical treatment of the topic can be found in *Uncertainty Analysis in Ecological Risk Assessment* (Warren-Hicks and Moore, 1998).

The approach for this particular risk and uncertainty assessment draws from the U.S. Army Corps of Engineers' *Guidelines for Risk and Uncertainty Analysis in Water Resources Planning* (Corps, 1992) (the Guidelines) and was designed to incorporate the Corps' general recommendations. The Guidelines define a risk and uncertainty analysis as being composed of an *assessment* and an *evaluation*. Under the Guidelines' definition, this study is a risk and uncertainty assessment. When describing the end use of the risk and uncertainty assessment in the planning process, the Guidelines identify two basic issues:

- The risk and uncertainty assessment should provide a clear picture of the reliability of the overall assessment.
- The assessment should provide useful taxonomies and identification of important questions relevant to risk management. It should highlight where political and social judgments have to be made.

The remainder of this section addresses the methods and results of dealing with these issues for the lower Snake River Juvenile Salmon Migration Feasibility Study.

8.2 Methods

The primary source of information for the risk and uncertainty assessment was the DREW workgroups. The workgroups provided three general types of information:

- Point and range estimates of NED costs and benefits of alternatives under consideration
- Verbal and/or written responses to a questionnaire designed to help ascertain the reliability of cost and benefit estimates and identify potentially important unanswered questions for risk managers
- Risk and uncertainty discussions prepared as part of their study reports

8.2.1 National Economic Development

The NED risk and uncertainty assessment used a combination of quantitative and qualitative methods described below. NED has the most fully developed risk and uncertainty assessment. Brief, qualitative risk and uncertainty assessments for social and regional analysis and tribal circumstances were conducted as well. The methods for these assessments are discussed following the NED methods section.

8.2.1.1 Quantitative Methods

The quantitative methodology used for the risk and uncertainty assessment is nominal range sensitivity analysis (NRSA). Other methods developed by the DREW risk and uncertainty workgroup included a spreadsheet tool for estimating probability distributions of cost variables and an expert elicitation protocol for estimating probability distributions. NRSA provided a simpler way to identify important uncertainties than these probabilistic methods. This in turn allowed the workgroups to spend more time refining their models and assumptions, rather than trying to assign probabilities to variables that, with the advantage of hindsight, might be shown through NRSA to be unlikely to affect the cost-effectiveness ranking of alternatives.

NRSA involves holding all cost parameters except one at their nominal values (i.e., best estimates), while varying the remaining parameter from its low-end to high-end range estimate. Thus for an additive model (e.g., a model that computes net benefit from component benefits and costs) the NRSA gives a set of $2n$ outputs describing the range of possible model outputs (net benefit) given the uncertainties of the input (component benefit and cost):

$$
\begin{aligned}
Y_{i,low} &= \sum_{\substack{j=1 \\ j \neq i}}^{n} X_{j,nom} + X_{i,low} \qquad (i = 1, \ldots, n) \\
Y_{i,high} &= \sum_{\substack{j=1 \\ j \neq i}}^{n} X_{j,nom} + X_{i,high} \qquad (i = 1, \ldots, n)
\end{aligned}
\tag{1}
$$

Nominal and range estimates were provided by individual workgroups on an average annual basis. These data, presented in Table 8-1, were used to compute the nominal net benefit associated with Alternatives 2 (Maximum Transport of Juvenile Salmon), 3 (Major System Improvements), and 4

(Dam Breaching) relative to Alternative 1 (Existing Conditions) at 6.875, 4.75, and 0 percent discount rates. This simply involved using the benefit and cost estimates reported in the nominal value column of Table 8-1. For example, the nominal net benefit, at the 6.875 percent discount rate, for Alternative 4 relative to Alternative 1 is computed using the Alternative 4 data from the nominal value column of the 6.875 percent discount rate section from Table 8-1:

= - (196,425+1,593) + (48,787 + 271,000 – 29,178 + 24,034 + 15,424)
= $132,049,000

Similarly, the nominal net benefit at the 0 percent discount rate for Alternative 3 relative to Alternative 1 is computed using the Alternative 3 data from the nominal value column of the 0 percent discount rate section from Table 8-1:

= (1,180 + 188) + (1,390 – 8,000 + 0 + 0 + 0)
= -$7,978,000

The nominal range sensitivity analysis computed net benefits for nominal net benefits, except that the low-end or high-end range estimate for one parameter was substituted for its nominal value, as described by equation 1. Thus, the low-end nominal range estimate (varying the Recreation Benefits parameter at the 6.875 percent discount rate) for Alternative 4 relative to Alternative 1 is computed using the Alternative 4 data from the nominal value column of the 6.875 percent discount rate section from Table 8-1. This calculation is made for all parameters except Recreation Benefits, for which the value in the low-end range estimate column is substituted:

= - (+ 56,000 + 1,593) + (48,787 + 271,000 – 29,178 + 24,034 + 15,424)
= $272,474,000

As a final example, the high-end nominal range estimate (varying the Power Costs parameter at the 4.75 percent discount rate) for Alternative 2 relative to Alternative 1, is computed using the Alternative 2 data from the nominal value column of the 4.75 percent discount rate section from Table 8-1. This calculation is made for all parameters except power costs, for which the value in the high-end range estimate column is substituted:

= - (+ 1,940 + 176) + (– 2,556 – 7,000 + 0 + 0 + 0)
= -$11,672,000

The nominal range sensitivity, computed as the absolute difference between the high- and low-end nominal range estimates, provides an estimate of the overall sensitivity of the nominal net benefit to the uncertainty in a particular parameter. For example, at the 4.75 percent discount rate, the nominal net benefit for Alternative 4 relative to Alternative 1 is – $96,321,000. The low- and high-end nominal range estimates for implementation costs are – $94,546,000 and – $98,096,000 so the nominal range sensitivity for implementation costs at the 4.75 percent discount rate is the absolute value of the difference:

= | (– $98,096,000) – (– $94,546,000) |
= $3,550,000

Table 8-1. Point and Range Estimates for NED Costs and Benefits Relative to Alternative 1 (1998 dollars) ($1,000s)

6.875 PERCENT DISCOUNT RATE				
Parameter	**Alternative**	**Nominal Value ($)**	**Low-End Range Estimate ($)**	**High-End Range Estimate ($)**
	1	-	-	-
Implementation Costs	2	3,457	3.284	3,630
	3	(5,931)	(5,634)	(6,228)
	4	(48,787)	(46.348)	(51,226)
	1	-	-	-
Power Costs	2	8,500	10,000	7,000
	3	8,500	10,000	7,000
	4	(271,000)	(251,000)	(291,000)
	1	-	-	-
Avoided Costs	2	-	-	-
	3	-	-	-
	4	29,178	27,719	30,637
	1	-	-	-
Navigation Costs	2	-	-	-
	3	-	-	-
	4	(24,034)	(20,000)	(30,000)
	1	-	-	-
Irrigation & Water System Costs	2	-	-	-
	3	-	-	-
	4	(15,424)	(13,919)	(16,928)
	1	-	-	-
Recreation Benefits	2	2,030	2,030	2,030
	3	2,080	2,080	2,080
	4	196,425	56,000	336,850
	1	-	-	-
Anadromous Fish Benefits	2	160	160	160
	3	161	161	161
	4	1,593	1,593	1,593

Table 8-1. Point and Range Estimates for NED Costs and Benefits Relative to Alternative 1 (1998 dollars) ($1,000s), continued

4.75 PERCENT DISCOUNT RATE				
Varied Parameter	**Alternative**	**Nominal Value ($)**	**Low-End Range Estimate ($)**	**High-End Range Estimate ($)**
	1	-	-	-
Implementation Costs	2	2,556	2,428	2,684
	3	(4,376)	(4,157)	(4,595)
	4	(35,498)	(33,723)	(37,273)
	1	-	-	-
Power Costs	2	8,500	10,000	7,000
	3	8,500	10,000	7,000
	4	(267,500)	(247,000)	(288,000)
	1	-	-	-
Avoided Costs	2	-	-	-
	3	-	-	-
	4	29,343	27,876	30,810
	1	-	-	-
Navigation Costs	2	-	-	-
	3	-	-	-
	4	(25,249)	(21,000)	(32,000)
	1	-	-	-
Irrigation & Water System Costs	2	-	-	-
	3	-	-	-
	4	(10,746)	(9,698)	(11,794)
	1	-	-	-
Recreation Benefits	2	1,940	1,940	1,940
	3	1,970	1,970	1,970
	4	211,430	62,120	360,740
	1	-	-	-
Anadromous Fish Benefits	2	176	176	176
	3	174	174	174
	4	2,064	2,064	2,064

Table 8-1. Point and Range Estimates for NED Costs and Benefits Relative to Alternative 1 (1998 dollars) ($1,000s), continued

0 PERCENT DISCOUNT RATE				
Varied Parameter	**Alternative**	**Nominal Value ($)**	**Low-End Range Estimate ($)**	**High-End Range Estimate ($)**
	1	-	-	-
Implementation Costs	2	663	630	696
	3	(1,390)	(1,321)	(1,460)
	4	(8,298)	(7,883)	(8,713)
	1	-	-	-
Power Costs	2	8,000	9,000	7,000
	3	8,000	9,000	7,000
	4	(263,500)	(241,000)	(286,000)
	1	-	-	-
Avoided Costs	2	-	-	-
	3	-	-	-
	4	29,050	27,598	30,503
	1	-	-	-
Navigation Costs	2	-	-	-
	3	-	-	-
	4	(28,330)	(24,000)	(35,000)
	1	-	-	-
Irrigation & Water System Costs	2	-	-	-
	3	-	-	-
	4	(2,241)	(2,022)	(2,459)
	1	-	-	-
Recreation Benefits	2	1,420	1,420	1,420
	3	1,180	1,180	1,180
	4	256,885	80,550	433,220
	1	-	-	-
Anadromous Fish Benefits	2	198	198	198
	3	188	188	188
	4	3,486	3,486	3,486

Paraphrasing, the estimate of the annual average net benefit of Alternative 4 relative to Alternative 1, at the 4.75 percent discount rate, has a sensitivity range of over $3 million due to uncertainty about implementation costs. While this level of uncertainty may seem high, uncertainty about implementation costs creates no uncertainty about the preferred alternative if one accepts the 4.75 percent discount rate, the nominal cost and benefit estimates, and the implementation costs range estimates for Alternative 4 relative to Alternative 1 provided in Table 8-1. At both the high and low ends of the sensitivity range, the annual net benefit of Alternative 1 exceeds the annual net benefit of Alternative 4 by over $90 million. In other words, uncertainty about implementation costs would not change a decision between Alternatives 1 and 4 based on a net benefit criterion; Alternative 1 would be the preferred alternative regardless of the value used for implementation costs.

The average of the high- and low-end nominal range estimates is a useful summary statistic for evaluating whether, given the parameter uncertainties, the point estimate of net benefits (the nominal value) is more likely to overestimate or underestimate the true value. So, looking again at the previous example, the average change for implementation costs at the 4.75 percent discount rate is:

$$\begin{aligned}
&= 0.5*(-\$98{,}096{,}000 - (-\$96{,}321{,}000)) + (-\$94{,}546{,}000 - (-\$96{,}321{,}000)) \\
&= 0.5*(-\$1{,}775{,}000 + \$1{,}775{,}000) \\
&= -\$0
\end{aligned}$$

The value of 0 for the average change for implementation costs is an indication that the nominal value for Alternative 4 relative to Alternative 1 at the 4.75 percent discount rate is more likely to underestimate than overestimate the relative net benefit of Alternative 1.

A final statistic computed as part of the nominal range sensitivity analysis is the normalized nominal range sensitivity:

$$\text{normalized nominal range sensitivity for parameter } i = \frac{\text{nominal range sensitivity for parameter } i}{\sum_{j=1}^{n} \text{nominal range sensitivity for parameter } j} \quad (2)$$

The normalized nominal range sensitivity provides an estimate of the relative sensitivity of relative net benefit to each parameter uncertainty. The normalized nominal range sensitivity falls between 0 and 1. Parameters with higher normalized nominal range sensitivities create greater uncertainty about relative net benefit than parameters with lower normalized nominal range sensitivities. Because they are relative values, normalized nominal range sensitivities are only comparable across parameters, not across alternatives or discount rates.

8.2.1.2 Qualitative Methods

Each DREW workgroup was asked to write a risk and uncertainty discussion as part of their study report. These sections tended to focus on describing data, methods, and results. Therefore, after reviewing the workgroups' risk and uncertainty discussions, follow-up questioning was conducted to better understand the choices and assumptions used in their analyses, how these affected results, and how they compared across workgroups. The follow-up questioning was necessary to understand the reliability of the overall assessment and important risk management questions, which, again, are the two basic risk and uncertainty assessment issues identified in the Guidelines (Corps, 1992). Workgroup leaders were asked to review an uncertainty worksheet and questionnaire, after which the risk and uncertainty team leader interviewed them. The worksheet and questionnaire used by the

workgroup leaders to prepare for their interviews with the risk and uncertainty team leader are provided in Figures 8-1 and 8-2.

Information gathered through interviews and other follow-up discussions with workgroup leaders was used to help interpret the results of the NRSA. The results presented below are based on the qualitative and quantitative data obtained by these methods.

This worksheet breaks out seven specific types of uncertainty. Please identify three to five uncertainties of each type that have the biggest potential impact on your workgroup's results and conclusions. The worksheet is intended to make it easier to respond to the questionnaire, so please complete the worksheet before starting the questionnaire. Thank you.

1. *Incomplete information* – missing data; also could include concerns about the representativeness of the available data.
2. *Natural variability* – conditions that change over time, vary among individuals, or change with location.
3. *Model structural uncertainty* – uncertainties about the correct way to describe something in a model, or approximation errors, due to the fact that models are just models, not perfect representations of the real world.
4. *Missing variables* – things not considered simply because we do not know about them, or enough about them, to include them in the analysis.
5. *Lack of understanding* – inability to fully understand available data and models.
6. *Disagreement* – legitimate differences of opinion about priorities or values that in turn affect the system being assessed or the questions we are trying to answer about it.
7. *Ambiguity* – sloppiness or imprecision in defining objectives, variables, assumptions, or decision criteria.

Figure 8-1. Risk and Uncertainty Worksheet

- How reliable, representative and complete were your data?
- What nagging concerns do you have about your data?
- How did you decide on the methods you adopted?
- What alternative methods might you have used?
- What nagging concerns do you have about your methods?
- How did you choose the models you used?
- What other models might you have used instead?
- What nagging concerns do you have about your models?
- What key assumptions did you make in your analysis?
- Why did you make these assumptions?
- What information would have been most useful to help you refine your assumptions?
- If you could change any of your assumptions, what would they be and why?
- If you generated scenarios, how extreme are your high and low scenarios?
- What is the most realistic scenario you can think of that would give results outside the range of scenarios you used? How likely is it?
- What is the most realistic scenario you can think of that would change your ranking of alternatives? How likely is it?
- In your opinion, what are the most important unanswered questions about your work group's piece of the project?
- If you had it to do over again, what would you do differently and why?

Figure 8-2. Risk and Uncertainty Questionnaire

8.2.2 Social and Regional Analysis

The workgroups that provided input to the social and regional analyses reported that uncertainty about future cost allocation decisions impaired their ability to derive useful data for assessing the social and regional impacts of the alternatives. The regional economic impact analysis suffered from significant errors and omissions that prevented the workgroup from engaging in a meaningful risk and uncertainty assessment, beyond simply documenting the major errors and omissions that exist. Similarly, the methodology for assessing social risks and uncertainties was limited to documenting major sources of uncertainty.

8.2.3 Tribal Circumstances

The methods used to develop the Tribal Circumstances and Perspectives report developed by a private contractor in association with the Columbia River Inter Tribal Fisheries Commission (CRITFC) (Meyer Resources, 1999) workgroup differed from those described above. This examined tribal levels of cultural and material wellbeing and distress. The report also evaluated risk and uncertainty separately, whereas the other workgroups combined the two related concepts.

The tribal circumstances uncertainty assessment focused on the reliability of workgroup's ordinal ranking of the alternatives for the four lower Snake River dams. They ranked the alternatives based on the estimated relative magnitude of salmon recovered for the tribes, as well as the direction and general effect of the estimated relative magnitude of salmon recovery on tribal culture, rates of death and health, poverty, employment/unemployment, and income. They also evaluated the reliability of their ordinal ranking of alternatives based on duration of near-current levels of tribal pain and suffering.

The tribal circumstances risk assessment focused on the consequences of possible errors in PATH estimates on tribal levels of cultural and material wellbeing and distress. They evaluated the consequences of over-estimation and under-estimation errors to determine whether tribal levels of cultural and material wellbeing and distress would increase or decrease, and whether they might undergo qualitative changes instead of just changes in degree (specifically, a change from pain and suffering to extinction). The tribal circumstances workgroup also provided narrative assessments of tribal risks (1) from delays in implementing measures affecting salmon recovery, and (2) if tribal interests are ignored or marginalized in the process of implementing measures affecting salmon recovery.

8.3 Results and Conclusions

8.3.1 National Economic Development

Table 8-2 presents NRSA results. In general, both Alternatives 2 and 3 provide positive net benefits relative to Alternative 1. None of the uncertainties reported by the workgroups changed this finding.

Comparing the two fish transport alternatives, Alternative 2 always provides positive net benefit relative to Alternative 3, although the magnitude of the difference between these two alternatives diminishes as the discount rate is decreased.

Looking at the normalized nominal range sensitivity, it can be seen that the greatest contributor to uncertainty about Alternative 2 is power cost uncertainty (90 percent) followed by implementation cost uncertainty (10 percent). The greatest contributor to uncertainty about Alternative 3 is power cost uncertainty (83 percent) followed by implementation cost uncertainty (17 percent).

Looking at the 6.875 percent discount rate in Table 8-2, it can be seen that recreational benefits account for approximately 82 percent of the normalized nominal range sensitivity for Alternative 4 versus Alternative 1, followed by power cost uncertainty (12 percent). Power costs do not affect the ranking of alternatives unless the low end nominal range estimate is used with a 0 percent discount rate. The power costs risk and uncertainty is important because (a) it is large relative to the other cost uncertainties, and (b) as the following paragraph discusses, it is considered by the hydropower workgroup (elsewhere referred to as the DREW Hydropower Impact Team [DREW HIT]). to be a reliable risk and uncertainty estimate. Because the power risk and uncertainty is large relative to other cost uncertainties and is reliable (i.e., the risk and uncertainty estimate is unlikely to change), it serves to dampen any effects of possible changes in other cost range estimates. In other words, other cost uncertainties are less important because they are small relative to the reliable power cost uncertainty estimates. Moreover, the power cost uncertainty does not affect the ranking of alternatives, so the other cost uncertainties are even less likely to do so. Therefore, the real driver in this analysis is the uncertainty about benefits. Following the discussion of the hydropower workgroup's NED analysis, the remainder of this section focuses on benefits uncertainty.

The hydropower workgroup reports that the data they used had a fairly high degree of reliability. Because they were forecasting future conditions, the most up-to-date data may have confirmed or slightly changed the forecasted values. Members of the workgroup had knowledge of recent data, however, and did not suggest any revisions in forecasts. The workgroup used a high-medium-low forecast for each key variable, and is confident that this covered likely future conditions. Of most importance in the workgroup's forecasts was the water supply available for power generation. They used two different hydro-regulation models to define this parameter, with actual historic water conditions over 60 years providing the model input data. The workgroup was not confident that their ancillary benefits estimates were based on the best data, but this element only made up 3 percent of the economic effects associated with dam removal. The hydropower workgroup used the three available power system models, from the Corps, BPA, and the NPPC. After examining many possible approaches, the workgroup agreed that a comparison of results from these three models would capture all the members' concerns about risk and uncertainty in the power systems component of their analysis. Any concerns the workgroup had were somewhat overcome once the members compared the results of the power system models. The workgroup found the results to be surprisingly close, so the results of any one model were confirmed by the others.

The hydropower workgroup identified three major assumptions in its analysis: zero price elasticity of electricity demand, the projected natural gas prices on the West Coast, and the projected demand for power (load forecasts). The zero price elasticity assumption does not account for the probable reduction in demand for electricity that will occur if electricity prices increase with the implementation of the Alternative 4. There is significant evidence that there is price elasticity for electricity at both the wholesale and retail level, but it was considered beyond the scope of the hydropower workgroup to estimate elasticity for each consumer type. The possible significance of this simplifying assumption can be qualified by looking at the examination of demand elasticity for electricity that was done in the Columbia River System Operation Review (SOR) on a cursory basis. The SOR evaluated economic effects of changes in hydropower generation in the Columbia River Basin using approaches similar to what was used in this study. The SOR also looked at the economic effects using a price elasticity approach for the different consumer types. The SOR found that once price elasticity was accounted for, the economic effects for losses in hydropower were about 11 percent lower than with the analysis that ignored price elasticity. Though this finding is not directly applicable to the Snake River breaching analysis, it can be used to give a general feeling for the impact of not including price elasticity.

The price and demand assumptions used are well documented in the hydropower workgroup's report. The workgroup chose to use the forecasts of gas prices and loads developed by the NPPC in recent studies. The NPPC studies were done in a very open public forum and many experts had a chance to review, comment, and revise these forecasts. The workgroup felt that a major change in the natural gas supply would have a significant impact on costs, but while an interruption in natural gas supplies could happen, the work group believes the impacts would likely be short-lived. In the long run, repairs or market shifts would return the gas supply and prices within the workgroup's forecasted range. The workgroup reported that a major economic depression would push load forecasts outside the forecasted ranges.

The most important results of the risk and uncertainty assessment are for comparisons of Alternative 4 (dam breaching) to any of the non-breaching alternatives. Specifically, the analysis shows that the ranking of Alternative 4 is highly sensitive to uncertainty about power and recreation.

Table 8-2. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s)

Varied Parameter	Alternative	Nominal Value ($)	Low-End Nominal Range Estimate ($)	High-End Nominal Range Estimate ($)	Change (Low) (%)	Change (High) (%)	Change (Low) ($)	Change (High) ($)	Nominal Range Sensitivity ($)	Average Change ($)	Normalized Nominal Range Sensitivity (%)
6.875 PERCENT DISCOUNT RATE											
	1	-	-	-	0	0	-	-	-	-	0
Implementation Costs	2	(14,147)	(13,974)	(14,320)	1	(1)	173	(173)	(346)	-	(10)
	3	(4,810)	(5,107)	(4,513)	(6)	6	(297)	297	(594)	-	(17)
	4	132,049	129,610	134,488	(2)	2	(2,439)	2,439	(4,878)	-	(1)
	1	-	-	-	0	0	-	-	-	-	0
Power Costs	2	(14,147)	(15,647)	(12,647)	(11)	11	(1,500)	1,500	(3,000)	-	(90)
	3	(4,810)	(6,310)	(3,310)	(31)	31	(1,500)	1,500	(3,000)	-	(83)
	4	132,049	112,049	152,049	(15)	15	(20,000)	20,000	(40,000)	-	(12)
	1	-	-	-	0	0	-	-	-	-	0
Avoided Costs	2	(14,147)	(14,147)	(14,147)	0	0	-	-	-	-	0
	3	(4,810)	(4,810)	(4,810)	0	0	-	-	-	-	0
	4	132,049	133,508	130,590	1	(1)	1,459	(1,459)	(2,918)	-	(1)
	1	-	-	-	0	0	-	-	-	-	0
Navigation Costs	2	(14,147)	(14,147)	(14,147)	0	0	-	-	-	-	0
	3	(4,810)	(4,810)	(4,810)	0	0	-	-	-	-	0
	4	132,049	128,015	138,015	(3)	5	(4,034)	5,966	(10,000)	966	(3)
	1	-	-	-	0	0	-	-	-	-	0
Irrigation & Water System Costs	2	(14,147)	(14,147)	(14,147)	0	0	-	-	-	-	0
	3	(4,810)	(4,810)	(4,810)	0	0	-	-	-	-	0
	4	132,049	130,544	133,553	(1)	1	(1,505)	1,505	(3,009)	-	(1)

Table 8-2. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s), continued

Varied Parameter	Alternative	Nominal Value ($)	Low-End Nominal Range Estimate ($)	High-End Nominal Range Estimate ($)	Change (Low) (%)	Change (High) (%)	Change (Low) ($)	Change (High) ($)	Nominal Range Sensitivity ($)	Average Change ($)	Normalized Nominal Range Sensitivity (%)
6.875 PERCENT DISCOUNT RATE											
	1	-	-	-	0	0	-	-	-	-	0
Recreation Benefits	2	(14,147)	(14,147)	(14,147)	0	0	-	-	-	-	0
	3	(4,810)	(4,810)	(4,810)	0	0	-	-	-	-	0
	4	132,049	272,474	(8,377)	106	(106)	140,425	(140,425)	(280,850)	-	(82)
	1	-	-	-	0	0	-	-	-	-	0
Anadromous Fish Benefits	2	(14,147)	(14,147)	(14,147)	0	0	-	-	-	-	0
	3	(4,810)	(4,810)	(4,810)	0	0	-	-	-	-	0
	4	132,049	132,049	132,049	0	0	-	-	-	-	0

Table 8-2. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s), continued

4.75 PERCENT DISCOUNT RATE											
Varied Parameter	**Alternative**	**Nominal Value ($)**	**Low-End Nominal Range Estimate ($)**	**High-End Nominal Range Estimate ($)**	**Change (Low) (%)**	**Change (High) (%)**	**Change (Low) ($)**	**Change (High) ($)**	**Nominal Range Sensitivity ($)**	**Average Change ($)**	**Normalized Nominal Range Sensitivity (%)**
	1	-	-	-	0	0	-	-	-	-	0
Implementation Costs	2	(13,172)	(13,044)	(13,300)	1	(1)	128	(128)	(256)	-	(8)
	3	(6,268)	(6,487)	(6,049)	(3)	3	(219)	219	(438)	-	(13)
	4	96,321	94,546	98,096	(2)	2	(1,775)	1,775	(3,550)	-	(1)
	1	-	-	-	0	0	-	-	-	-	0
Power Costs	2	(13,172)	(14,672)	(11,672)	(11)	11	(1,500)	1,500	(3,000)	-	(92)
	3	(6,268)	(7,768)	(4,768)	(24)	24	(1,500)	1,500	(3,000)	-	(87)
	4	96,321	75,821	116,821	(21)	21	(20,500)	20,500	(41,000)	-	(11)
	1	-	-	-	0	0	-	-	-	-	0
Avoided Costs	2	(13,172)	(13,172)	(13,172)	0	0	-	-	-	-	0
	3	(6,268)	(6,268)	(6,268)	0	0	-	-	-	-	0
	4	96,321	97,780	94,862	2	(2)	1,459	(1,459)	(2,918)	-	(1)
	1	-	-	-	0	0	-	-	-	-	0
Navigation Costs	2	(13,172)	(13,172)	(13,172)	0	0	-	-	-	-	0
	3	(6,268)	(6,268)	(6,268)	0	0	-	-	-	-	0
	4	96,321	92,072	103,072	(4)	7	(4,249)	6,751	(11,000)	1,251	(3)
	1	-	-	-	0	0	-	-	-	-	0
Irrigation & Water System Costs	2	(13,172)	(13,172)	(13,172)	0	0	-	-	-	-	0
	3	(6,268)	(6,268)	(6,268)	0	0	-	-	-	-	0
	4	96,321	95,273	97,369	(1)	1	(1,048)	1,048	(2,096)	-	(1)

Table 8-2. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s), continued

Varied Parameter	Alternative	Nominal Value ($)	Low-End Nominal Range Estimate ($)	High-End Nominal Range Estimate ($)	Change (Low) (%)	Change (High) (%)	Change (Low) ($)	Change (High) ($)	Nominal Range Sensitivity ($)	Average Change ($)	Normalized Nominal Range Sensitivity (%)
4.75 PERCENT DISCOUNT RATE											
Recreation Benefits	1	-	-	-	0	0	-	-	-	-	0
	2	(13,172)	(13,172)	(13,172)	0	0	-	-	-	-	0
	3	(6,268)	(6,268)	(6,268)	0	0	-	-	-	-	0
	4	96,321	245,631	(52,989)	155	(155)	149,310	(149,310)	(298,620)	-	(83)
Anadromous Fish Benefits	1	-	-	-	0	0	-	-	-	-	0
	2	(13,172)	(13,172)	(13,172)	0	0	-	-	-	-	0
	3	(6,268)	(6,268)	(6,268)	0	0	-	-	-	-	0
	4	96,321	96,321	96,321	0	0	-	-	-	-	0

Table 8-2. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s), continued

Varied Parameter	Alternative	Nominal Value ($)	Low-End Nominal Range Estimate ($)	High-End Nominal Range Estimate ($)	Change (Low) (%)	Change (High) (%)	Change (Low) ($)	Change (High) ($)	Nominal Range Sensitivity ($)	Average Change ($)	Normalized Nominal Range Sensitivity (%)
0 PERCENT DISCOUNT RATE											
	1	-	-	-	0	0	-	-	-	-	0
Implementation Costs	2	(10,281)	(10,248)	(13,248)	0	(29)	33	(2,967)	(3,000)	(1,467)	(60)
	3	(7,978)	(8,047)	(7,908)	(1)	1	(69)	70	(139)	1	(6)
	4	12,820	12,405	13,235	(3)	3	(415)	415	(830)	-	0
	1	-	-	-	0	0	-	-	-	-	0
Power Costs	2	(10,281)	(11,281)	(9,281)	(10)	10	(1,000)	1,000	(2,000)	-	(40)
	3	(7,978)	(8,978)	(6,978)	(13)	13	(1,000)	1,000	(2,000)	-	(94)
	4	12,820	(9,681)	35,320	(176)	176	(22,500)	22,500	(45,000)	-	(11)
	1	-	-	-	0	0	-	-	-	-	0
Avoided Costs	2	(10,281)	(10,281)	(10,281)	0	0	-	-	-	-	0
	3	(7,978)	(7,978)	(7,978)	0	0	-	-	-	-	0
	4	12,820	14,279	11,361	11	(11)	1,459	(1,459)	(2,918)	-	(1)
	1	-	-	-	0	0	-	-	-	-	0
Navigation Costs	2	(10,281)	(10,281)	(10,281)	0	0	-	-	-	-	0
	3	(7,978)	(7,978)	(7,978)	0	0	-	-	-	-	0
	4	12,820	8,490	19,490	(34)	52	(4,330)	6,670	(11,000)	1,170	(3)

Table 8-2. Nominal Range Sensitivity Analysis of Net Benefit Difference from Alternative 1 ($1,000s), continued

Varied Parameter	Alternative	Nominal Value ($)	Low-End Nominal Range Estimate ($)	High-End Nominal Range Estimate ($)	Change (Low) (%)	Change (High) (%)	Change (Low) ($)	Change (High) ($)	Nominal Range Sensitivity ($)	Average Change ($)	Normalized Nominal Range Sensitivity (%)
0 PERCENT DISCOUNT RATE											
	1	-	-	-	0	0	-	-	-	-	0
Irrigation & Water System Costs	2	(10,281)	(10,281)	(10,281)	0	0	-	-	-	-	0
	3	(7,978)	(7,978)	(7,978)	0	0	-	-	-	-	0
	4	12,820	12,601	13,038	(2)	2	(219)	219	(437)	-	0
	1	-	-	-	0	0	-	-	-	-	0
Recreation Benefits	2	(10,281)	(10,281)	(10,281)	0	0	-	-	-	-	0
	3	(7,978)	(7,978)	(7,978)	0	0	-	-	-	-	0
	4	12,820	189,155	(163,516)	1376	(1376)	176,335	(176,335)	(352,670)	-	(85)
	1	-	-	-	0	0	-	-	-	-	0
Anadromous Fish Benefits	2	(10,281)	(10,281)	(10,281)	0	0	-	-	-	-	0
	3	(7,978)	(7,978)	(7,978)	0	0	-	-	-	-	0
	4	12,820	12,820	12,820	0	0	-	-	-	-	0

For the Alternative 4 to Alternative 1 comparison. the nominal range sensitivity to uncertainty about recreational benefits ranges from $280.850.000 at a 6.875 percent discount rate to $352.670.000 at a 0 percent discount rate (difference between the average annual net benefit of Alternative 4 and Alternative 1).

Table 8-5 shows how passive use benefits would affect the net benefit of Alternative 4 if they were included in the NED analysis. Passive use benefits for salmon were estimated using four different methods, resulting in four different estimates. Each of these four salmon passive use benefits estimates was added to the single free-flowing river passive use benefits estimate to obtain four different total passive use benefits estimates. Table 8-3 shows how these four estimates would affect the net benefit of Alternative 4 relative to Alternative 1 at the nominal case, and when power and recreation estimates are at the low or high end of their range estimates for the various discount rates. Adding in any of the four passive use benefits estimates would cause Alternative 4 to become the most highly ranked alternative at all discount rates, regardless of whether power or recreation are at the high or low end of their range estimates.

Table 8-3. Effect of Passive Use Benefits Estimates on Value of Alternative 4 Relative to Alternative 1 ($1000s)

Nominal Range Scenario	Difference Between Alternatives 1 and 4 (No Passive Use Benefits)	Including Passive Use Estimate 1 ($486,000)	Including Passive Use Estimate 2 ($562,000)	Including Passive Use Estimate 3 ($928,000)	Including Passive Use Estimate 4 ($1,299,000)
6.875 Percent Discount Rate					
Low-End Power	(112,049.00)	373,951.00	449,951.00	815,951.00	1,186,951.00
High-End Power	(152,049.00)	333,951.00	409,951.00	775,951.00	1,146,951.00
Low-End Recreation	(272,474.00)	213,526.00	289,526.00	655,526.00	1,026,526.00
High-End Recreation	8,377.00	494,377.00	570,377.00	936,377.00	1,307,377.00
Nominal	(132,049.00)	353,951.00	429,951.00	795,951.00	1,166,951.00
4.75 Percent Discount Rate					
Low-End Power	(75,821.00)	410,179.00	486,179.00	852,179.00	1,223,179.00
High-End Power	(116,821.00)	369,179.00	445,179.00	811,179.00	1,182,179.00
Low-End Recreation	(245,631.00)	240,369.00	316,369.00	682,369.00	1,053,369.00
High-End Recreation	52,989.00	538,989.00	614,989.00	980,989.00	1,351,989.00
Nominal	(96,321.00)	389,679.00	465,679.00	831,679.00	1,202,679.00
0 Percent Discount Rate					
Low-End Power	9,681.00	495,681.00	571,681.00	937,681.00	1,308,681.00
High-End Power	35,320.00	521,320.00	597,320.00	963,320.00	1,334,320.00
Low-End Recreation	(189,155.00)	296,845.00	372,845.00	738,845.00	1,109,845.00
High-End Recreation	163,516.00	649,516.00	725,516.00	1,091,516.00	1,462,516.00
Nominal	(12,820.00)	473,180.00	549,180.00	915,180.00	1,286,180.00

Figures 8-3 to 8-5 show the relative sensitivity of the difference between the average annual net benefit of Alternative 4 and Alternative 1 to each input at the three discount rates used in the economic analyses. It can be seen from these figures that recreation and passive use benefits uncertainties are of predominant importance, regardless of which of the three discount rates is used.

Not only are the nominal range sensitivities for recreation and passive use benefits high, but the ranking of alternatives changes. Looking again at Table 8-2, it can be seen that using the low-end nominal range estimate, the ranking is Alternative 2, Alternative 3, Alternative 1, Alternative 4. Using the high-end nominal range estimate, however, switches the ranking to Alternative 4, Alternative 2, Alternative 3, Alternative 1. In other words, whether breaching the four lower Snake River dams will give a positive or negative net NED benefit is unknown, because of the current level of uncertainty about the value of recreational and passive use benefits.

Even though the question of whether to breach the four lower Snake River dams is already highly sensitive to uncertainty about recreational and passive use benefits, the NRSA probably underestimates the recreational benefits uncertainty because it does not account for uncertainty in PATH estimates. The recreational benefits estimate is based on a point estimate of the size of the recreational fishery that would be available if the four lower Snake River dams were breached. Current PATH results predict a high level of unfulfilled recreational fishing demand (on the order of 95 percent of demand unfulfilled), indicating that the recreational fishing benefit is likely sensitive to the PATH estimate.

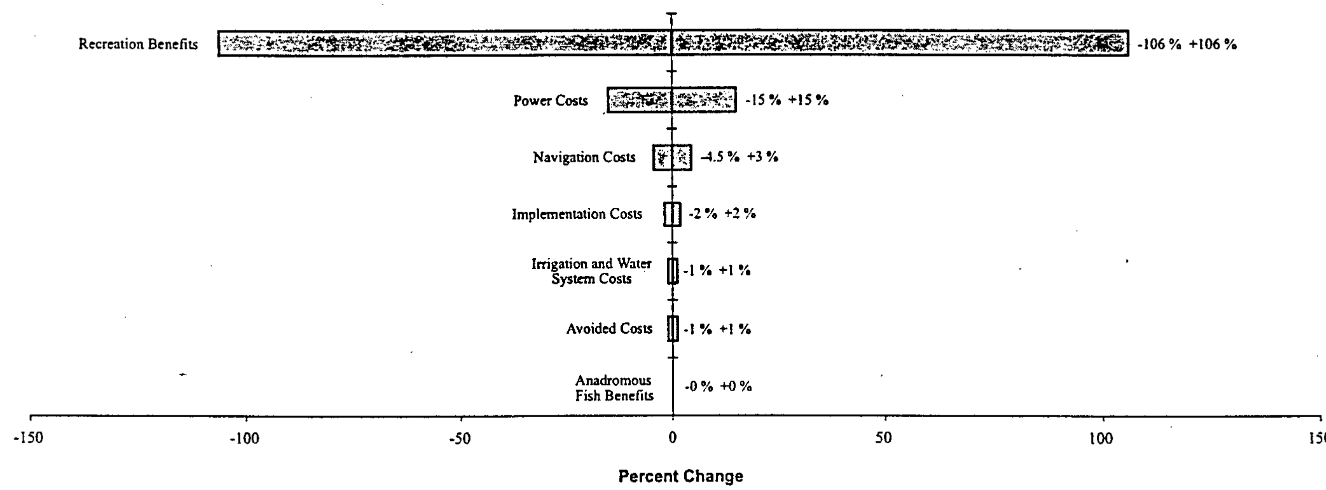

Figure 8-3. Nominal Range Sensitivity Expressed as Percent Change in the Difference Between Average Annual Net Benefit of Alternative 4 And Alternative 1 @ 6.875 Percent Discount Rate

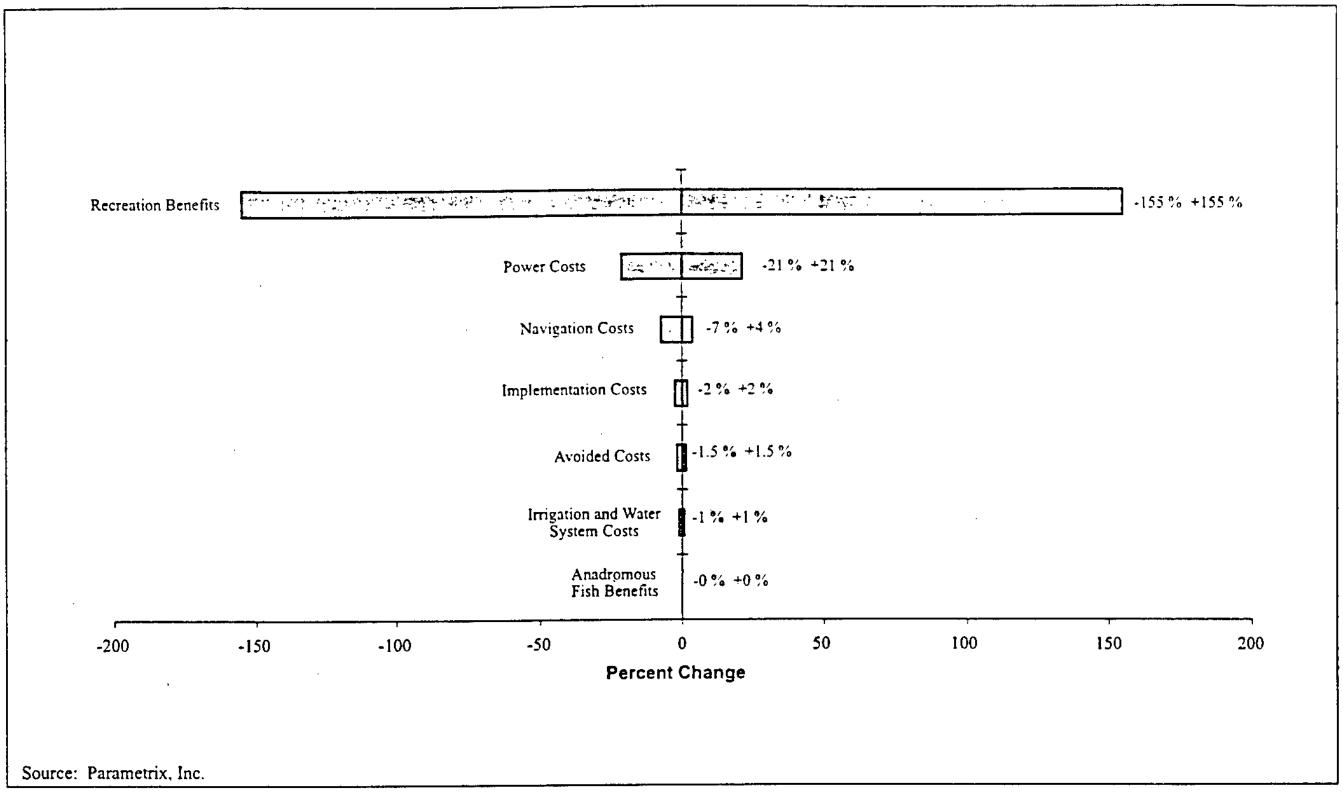

Figure 8-4. Nominal Range Sensitivity Expressed as Percent Change in the Difference Between Average Annual Net Benefit of Alternative 4 And Alternative 1 @ 4.75 Percent Discount Rate

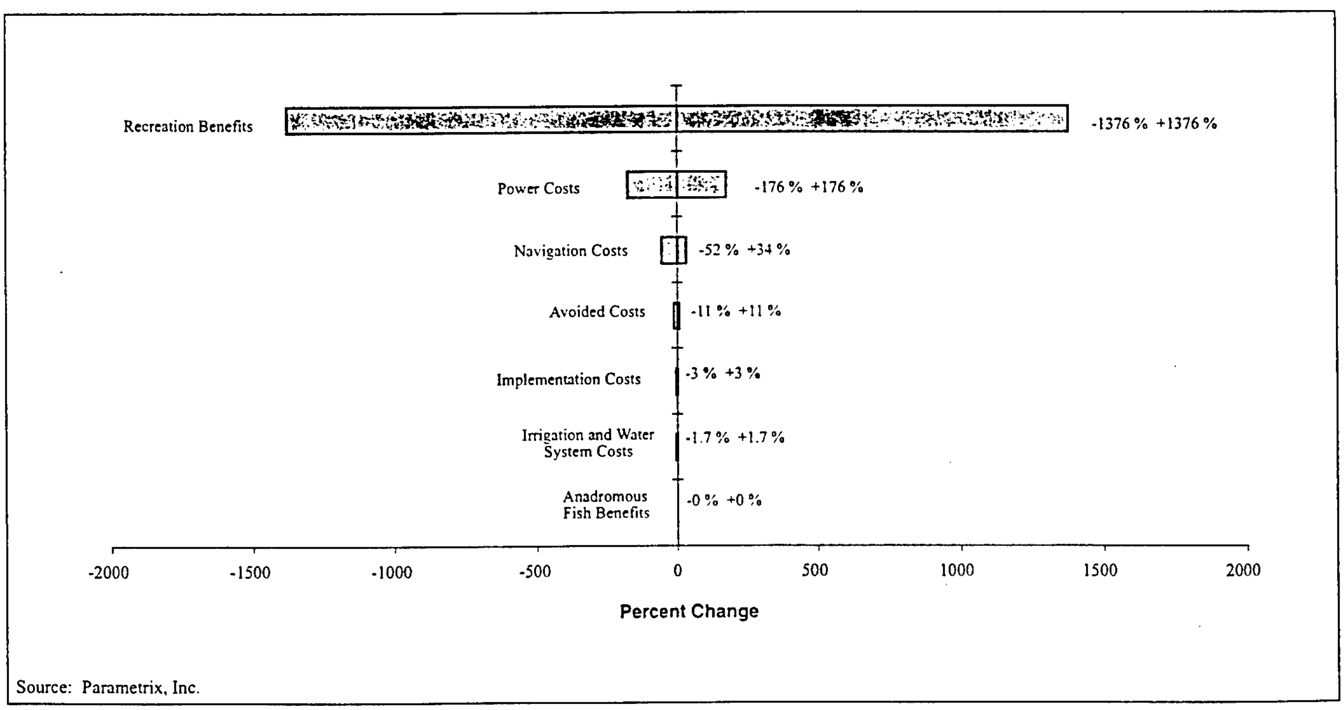

Figure 8-5. Nominal Range Sensitivity Expressed as Percent Change in the Difference Between Average Annual Net Benefit of Alternative 4 And Alternative 1 @ 0 percent Discount Rate

The interview with the recreation use benefits workgroup revealed two others factors that will tend to increase the average annual net benefits of Alternative 4 relative to Alternative 1. First, the recreation benefits report characterizes the estimates of California visitation as conservative (low). Although the degree of conservatism has not been quantified, any increase would increase the average annual net benefits of Alternative 4 relative to Alternative 1. California households make up about 70 percent of the study region's population. Second, the analysis has not accounted for the value of observing natural recovery of the lower Snake River if the dams are breached.

Range estimates were not available for the anadromous fish benefits. Non-linearity in the models used did not allow for ranges to be determined. Therefore, it is impossible to evaluate how range estimates for anadromous fish benefits may affect the ranking of alternatives.

There is a great deal of uncertainty in the recreational benefits of Alternatives 1, 2, 3, and 4 that is not reflected in the NED analysis. Uncertainties about the best methods for estimating these values are represented, but uncertainties within the methods themselves are not. Reservoir recreation benefits represent three-fourths of the recreational benefits of non-drawdown Alternatives (1, 2, and 3) and the confidence intervals are large ($47 to $148 a trip), indicating a great deal of uncertainty in the values. This uncertainty is not reflected in the NED analysis because only a point estimate was used (mean value of 71.31 per trip). The range of recreational benefits for Alternative 4 reflects different treatment of the data based on assumptions about non-respondent behavior. However, the range of recreational benefits used in the NED analysis were based one only one assumption about non-respondent data (middle use estimates, or assuming non-respondent use is the same as respondent use, but only using the rates for definite rather than probable visitors). River recreation benefits represent a large portion of the recreation benefits of Alternative 4. The low-end range estimate was based on scaling the river recreation and fishing demand curve using the cost per mile of reservoir visitors (travel cost method). A mean value of $71.36 per trip was used for the low end, but does not reflect the large confidence intervals for this method (95 percent confidence interval of $39 to $446 per trip). The high-end range estimate was based on scaling the demand curve using costs of visitors to free-flowing river sections as reported in a contingent behavior survey.. A mean value of $297 per trip was used for the high end, which does not reflect the large confidence intervals for this method (95 percent confidence interval of $181 to $831 per trip). The nominal recreational benefits reflect the average of the mean of these two methods. Therefore, the Alternative 4 benefits reflect uncertainty about which method is the best estimator, but do not reflect uncertainty in the methods themselves. Also, recreational suitability recovery for various activities under Alternative 4 was based on point estimates, rather than range estimates, and no confidence limits were determined. If the confidence limits were included in the NED analysis, a larger range of possible values for recreational benefits would have occurred.

The DREW Recreation Workgroup indicated in their passive use report (see Section 4, Passive Use) that the nature of the existing surveys used for the benefit transfer study resulted in a number of factors that suggested that the resulting estimates might be called conservative. These include:

- Survey respondents were not told that they were evaluating threatened and endangered stocks. Providing respondents with this information would likely result in higher estimates of passive use benefits.
- Most existing studies evaluated a larger fish increase than is being evaluated in the lower Snake River. Because studies find that larger increases have diminishing returns on willingness to pay, applying these numbers to the lower Snake River likely underestimates its passive use benefits.

- The estimate of passive use benefits assumed zero benefit for angler households in the study area and zero benefit for all households outside of the study area.

Passive use benefits consist of salmon values and free-flowing river values. The range of values presented for passive use benefits of salmon reflect different approaches for estimating values, rather than uncertainties in the methods themselves. A single point estimate was available for the free-flowing river passive use benefits, and no confidence intervals were determined. Given that a number of conservative assumptions were used, passive use benefits are likely to be underestimated, but it is difficult to say by how much.

8.3.2 Social and Regional Analysis

The driving uncertainties in the regional analysis are identified errors and omissions, which are identified in the DREW Regional Analysis Workgroup (1999) report. The regional analysis workgroup reports that uncertainty is present in the regional economic impact analysis because of uncertainties in inputs received from other workgroups and uncertainties used to drive the models. The regional analysis workgroup noted that errors in the input data received from the other workgroups will be multiplied when the data are used in the regional economic impact model. The regional analysis workgroup identified the following specific examples of errors, omissions, and uncertainty in the input data they used in their analysis:

- The data for the 100-year fishing and outdoor recreation projections were based on now obsolete PATH analysis and since improved salmon life-cycle analysis. This has repercussions for the comparisons of outcomes in the recreation section of the regional analysis.
- The effect of increased shipping costs under Alternative 4 on industry output and employment for firms that use barge shipping was not studied, so changes in outputs and employment in the wood products, grain production, and other sectors are unknown.
- Effects of reduction in irrigated agriculture under Alternative 4 on the food processing sector are unknown.
- The required road investment outside Washington under Alternative 4 is unknown, as are future increases in spending for road maintenance.
- The future distribution of electricity rate increases under Alternative 4 across regions, industries, or consumers is unknown.

The hydropower workgroup elaborated on this last point in its interview with the risk and uncertainty workgroup. The members identified the possible rate impacts to regional power ratepayers as the only major risk and uncertainty concern. The workgroup expressed confidence in the reliability of its NED cost range estimate, but not in its ability to define who will pay these costs. This impacts the regional analysis and may be of significant social importance. The hydropower workgroup cannot improve the rate analysis until Congress determines the methods for funding dam removal. This would be done in the authorizing legislation if Alternative 4, Dam Breaching, were selected.

The executive summary of the Regional Economic Impact Models for the lower Snake River Juvenile Salmon Migration Feasibility Study also discusses the risk and uncertainty of the input-output economic analysis technique. First, industry spending calibrations are based on national averages, which may not apply to the specific region under study. Estimates using the national

averages are, however, likely to be within plus or minus 10 percent of multipliers that would be found using survey data. Second, the input-output analysis provides a "snapshot" of the economy at a point in time rather than a dynamic structure of changing relationships. No model can make accurate predictions of future changes in technology, prices, trade patterns, or consumer tastes and preferences, therefore, all models would suffer this same uncertainty. Third, the input-output model is driven by exogenous estimates of changes in sale to final demand (exports, investment, and certain components of government spending).

Finally, the social workgroup identified four sources of uncertainty about the appropriateness of some of the assumptions used in the social analysis:

- Allocation of sub-regional employment impacts to local communities based on a proportion of local employment to regional employment changes may understate or overstate the magnitude of impacts.
- Use of social indicators (e.g., steelhead fishing licenses) to represent the contribution of anadromous fish to local quality of life, poverty rates to identify populations sensitive to economic changes, developed recreation sites to indicate quality of life.
- Use of county level farm data to make generalizations about the expected changes to farming communities within the county.
- Assuming that positive gains in employment are positive and negative losses in employment are negative for a given community.

The social analysis report additionally identified significant uncertainty in the economic effects of Alternative 4 on upriver communities because it is unknown how significantly the loss of river navigation will affect the forest paper industry. Also, the effects of electrical rate increases on the aluminum industry are unknown, but could have significant regional impacts. The report also identified five key uncertainties that make the prediction of impacts on individual farms, farm regions, counties, and rural farm communities difficult to determine:

1. The future of farm deficiency payments may be extended.
2. International market conditions and prices received for export agricultural products vary greatly from year to year.
3. The fixed and variable costs of farming have increased over time and may continue to do so while at the same time new crops and rotations are being introduced to the region.
4. Technological advances in crop production and seasonal variations in rainfall make forecasting average yields difficult for more than 1 year in advance.
5. The actual magnitude of total transportation cost increases, including price adjustments for alternative modes of transportation in the absence of barges, is unknown at this time.

8.3.3 Tribal Circumstances

The tribal circumstances risk and uncertainty assessment was obtained from the Tribal Circumstances and Perspectives report.

8.3.3.1 Uncertainty

The Tribal Circumstances and Perspectives report identifies positive associations between abundance of tribal harvest of salmon, and tribal levels of cultural and material wellbeing, or

alternatively, of distress – indexed by perception of self, rates of death, health, poverty, unemployment, and per capita income.

Given information presently available, it is not possible to establish certain cardinal measurement linkages between such "cause and effect" parameters – either in the immediate term, or cumulatively.

The Tribal Circumstances and Perspectives report ranked the alternatives based on the relative magnitude of salmon recovered for the tribes under each project alternative, and respecting the direction and general effect of such respective magnitudes of salmon recovery on tribal culture, rates of death and health, poverty, employment/unemployment, and income.

Similarly, the Tribal Circumstances and Perspectives report provides a clear separation with respect to the length of time over which tribal pain and suffering would continue at close to present levels, under each project alternative.

The Tribal Circumstances and Perspectives report indicates that changes in underlying biological assumptions regarding recovery would result in some changes to cardinal estimates of salmon recovery. It further explains that such changes are not likely to substantially change the certainty associated with the ranking of tribal impacts from alternative project choices.

8.3.3.2 Tribal Risk

According to the Tribal Circumstances and Perspectives report, the tribes face four major elements of risk within the context of the lower Snake River Feasibility Study process.

First, the Tribal Circumstances and Perspectives report identified the close dependence of the study tribes on salmon, the declines in salmon available to the tribes from Treaty times to the present, and the consequent endangerment of not only the salmon, but the cultural and material wellbeing of the tribes as well.

Given present diminished stock levels, if the PATH estimates are too optimistic, there is a risk that the subject salmon species will become extinct – with attendant risks for continued survival of tribal peoples.

Second, if PATH recovery estimates are too pessimistic, differences in the magnitude and timing of salmon recovery between alternatives would be understated – reducing comparative net benefits posed for the alternative most likely to restore salmon.

Third, if the selected alternative forecasts salmon recovery that will need a time period far into the future before significant harvests are returned to the tribes, the Tribal Circumstances and Perspectives report indicates that tribal peoples will continue to risk unacceptable levels of pain, suffering and premature death, while bureaucrats "test and study."

Finally, the Tribal Circumstances and Perspectives report identifies that in almost all prior processes concerning Columbia/Snake River system dams, tribal concerns and the impact on tribes have been ignored or marginalized. The Tribal Circumstances and Perspectives report identifies that if marginalization occurs during the present process, the cumulative transfer of the river system's wealth from tribal to non-tribal residents of the region will continue – tribal peoples will continue to suffer and be disempowered, regardless of existing Treaty protections – and environmental injustice, as defined by EPA, will be exacerbated.

8.3.3.3 PATH Analysis

Data from the PATH analysis are used for a number of parts of the Economics Appendix I the lower Snake River Juvenile Salmon Migration Feasibility Study. Changes in the PATH results will directly affect estimates under different alternatives for commercial and recreational fishing, regional and social analysis, tribal circumstances, and passive and recreation use benefits. Uncertainties in each of these areas are multiplied by uncertainties in the PATH analysis; therefore changes in the PATH analysis can potentially change the ranking of alternatives. PATH has recently (November 1999) revised its estimates, but the economic studies presented in this document were developed using its previous estimates. This is a significant source of uncertainty in the NED analysis and may affect the ranking of alternatives.

The conclusions and recommendations from the PATH weight of evidence workshop quantified the relative degree of belief in the seven key uncertainties that have the greatest effect on the outcomes of management actions. The seven key uncertainties are:

1. Passage and transportation assumptions (uncertainty in direct survival of in-river fish, the partitioning of in-river survival between dam and reservoir survival, and survival of transported versus non-transported fish after they have exited the migration corridor).
2. Extra mortality outside of the juvenile migration corridor that is not accounted for by productivity parameters in spawner/recruit relationships, by estimates of direct mortality in the migration corridor, or common year effects affecting both Snake River and lower Columbia River Stocks (delta model only).
3. Uncertainty in the extent to which Snake River and lower Columbia share common mortality effects.
4. Length of the transition period between removal of dams and establishment of equilibrium in the drawndown section of the Snake River (reflecting uncertainty in physical and biological responses to drawdown).
5. Uncertainties in historical estimates of bypass and turbine mortality.
6. Uncertainty in the effect of the predator removal program (i.e., squawfish bounties) on future survival of salmon smolts in reservoirs.
7. Uncertainty of juvenile survival rate once equilibrium conditions have been reached.

Alternative hypotheses for each of these seven uncertainties were identified, and expert elicitation was used to determine belief in the hypothesis used versus the alternatives. Weighted averages were derived by four different experts for each hypothesis under each of the seven uncertainties. These weights were used to determine weighted averages for 24-year survival, 100-year survival, and 48-year recovery standards. The weighted averages show what the most likely outcomes of the actions will be, given uncertainties that affect future projections. Table 8-4 shows how meeting the standards is affected by using the sets of judgements from the different experts. The following conclusions were reached based on this analysis:

- The analysis determined that outcomes for Alternative 4 are better than those of Alternative 1 or Alternative 2 for all jeopardy standards, regardless of the expert used. The magnitude of the differences depends on the jeopardy standard used and assumptions about when drawdown will be implemented.
- The ability of actions to meet the 24-year survival standard varies with different experts. meets the standard with one out of four experts. Alternative 2 fails the standard regardless of

the expert. Drawdown with a 3-year delay meets the standard with three of the four sets of experts, while drawdown with an 8-year delay meets the standard with two of the four experts.

- Alternative 1 and Alternative 4 (both 3-year and 8-year) meet the 100-year survival standard regardless of the expert. Alternative 2 meets the 100-year survival standard with three of four experts.
- Alternative 1 and Alternative 2 meet the 48-year recovery standard with one of four experts. Alternative 4 meets the 48-year recovery standard with all experts regardless of whether a 3-year or 8-year delay is assumed.

PATH probabilities for achieving 24-year, 48-year, and 100-year escapement levels for survival and recovery were generally used as fixed point values in the NED analysis. The PATH numbers were generated using Monte Carlo simulations that established distribution ranges for the returning salmon stocks. The NED analysis did not use these distribution ranges but instead used fixed point estimates from the ranges. This represents a significant uncertainty that was not accounted for in the NED analysis. Using a point estimate could significantly overestimate or underestimate the salmon population.

The scientific review panel (SRP) also considered whether there were any new hypotheses that should be included in the PATH models. One hypothesis that the SRP thought worth evaluating was that hatchery fish might affect the survival of wild fish. This hypothesis was believed to have significant results on survival. The implementation of this hypothesis was not considered feasible because:

Table 8-4. Weighted Average Performance Measure

Expert	Action	24-year Survival	100-year Survival	48-year Recovery
1	1	x	x	x
	2		x	x
	4 (3-year)	x	x	x
	4 (8-year)	x	x	x
2	1		x	
	2			
	4 (3-year)		x	x
	4 (8-year)		x	x
3	1		x	
	2		x	
	4 (3-year)	x	x	x
	4 (8-year)		x	x
4	1		x	
	2		x	
	4 (3-year)	x	x	x
	4 (8-year)	x	x	x

Note: x = Meets Standard

9. Cost Effectiveness

9.1 Introduction & Study Organization

The purpose of the cost effectiveness analysis is to identify the least cost method for providing various levels of output. For example, if two of the alternatives under consideration meet the NMFS jeopardy standards, then cost effectiveness analysis helps to establish the less costly alternative.

The following chapter reports the results of the cost effectiveness analysis. It should be noted that this report only deals with NED costs and benefits, as defined by the Corps. The chapter is divided into five sections: introduction and study organization, discussion of biological outputs, discussion of net cost factors, cost effectiveness comparisons, and conclusions.

9.2 Discussion of Biological Outputs

There are four species of fish in the lower Snake River system that have been listed as endangered or threatened by NMFS under the Endangered Species Act, including spring/summer chinook, fall chinook, steelhead, and sockeye. The effects of the proposed alternatives in improving the chances of recovery and survival of these species are considered the "benefits" or “output” of undertaking the study alternatives. The following section reviews the development and application of the NMFS jeopardy standards.

The PATH analysis was based upon the sixth weakest of seven stocks of spring/summer chinook and one stock of fall chinook but PATH results were not extrapolated to the entire population of lower Snake River chinook. Data were not available to provide PATH modeling for steelhead and sockeye.

The DREW Anadromous Fish Workgroup, working in coordination with staff from NMFS and members of PATH, extrapolated the results of the PATH analysis to all lower Snake River spring/summer and fall chinook stocks and also prepared estimates for steelhead, which are believed to have a similar biological response to that of spring/summer chinook. Neither PATH nor the DREW Anadromous Fish Workgroup prepared estimates for sockeye, because there were insufficient data.

9.2.1 PATH Model Results

PATH is a formal and rigorous program of formulating and testing hypotheses by using a series of model simulations to estimate both past and future trends in fish abundance for each of the selected stocks. The primary objective of PATH’s modeling is to enhance the survival opportunities of the affected ESUs by considering the stock’s response to jeopardy standards, which were defined by the Biological Requirements Working Group (BRWG) and largely accepted by NMFS. (Source: Peters et al., 1999).

9.2.1.1 Definition of Jeopardy Standards

The jeopardy standards include both survival and recovery goals as defined below:

- Survival standards (which set the threshold for survival) are based on projected probabilities that the spawning abundance will exceed a pre-defined survival threshold over a 24- or 100-year simulation period. Survival standards are met when that probability is 70 percent or greater .
- Recovery standards (which are required to consider de-listing of the species) are based on probabilities of exceeding a recovery threshold in the last 8 years of a 48-year simulation period. This standard is met when the probability is 50 percent or greater" (PATH memo to IT team).

9.2.1.2 Spring/Summer Chinook 1998 Model Results

Table 9-1 presents the probability of each alternative meeting the NMFS 24-year and 100-year survival standards and the 48-year recovery standards for spring/summer chinook using data from the 1998 PATH model results as reported by NMFS. This table presents the median modeling results, which are considered the most likely outcome, as well as the 25th and 75th percentile model results, which bound the median result with a range from low to high outcomes.

Table 9-1. Probability of Attaining NMFS Jeopardy Standards for Spring/Summer Chinook Using Unweighted 1998 Model Results

		24-Year Survival	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1, Existing Conditions	0.67	0.55	0.75
Alternative 2, Maximum Transport of Juvenile Salmon	0.65	0.54	0.75
Alternative 3, Major System Improvements	0.66	0.55	0.75
Alternative 4, Dam Breaching	0.69	0.63	0.76
		48-Year Recovery	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1, Existing Conditions	0.48	0.31	0.65
Alternative 2, Maximum Transport of Juvenile Salmon	0.45	0.29	0.66
Alternative 3, Major System Improvements	0.46	0.31	0.67
Alternative 4, Dam Breaching	0.84	0.74	0.92
		100-Year Survival	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1, Existing Conditions	0.79	0.68	0.87
Alternative 2, Maximum Transport of Juvenile Salmon	0.78	0.65	0.87
Alternative 3, Major System Improvements	0.79	0.67	0.87
Alternative 4, Dam Breaching	0.89	0.85	0.92

Source: Personal communication from NMFS

24-Year Survival Standard for Spring/Summer Chinook

None of the median results of any the alternatives under consideration meet the 24-year survival standards, which as discussed above, require a 70 percent probability. However, the median results of all alternatives are relatively close to the survival standard (e.g., within 1 percent to 5 percent of meeting this standard). In addition, all alternatives meet the standard under the 75th percentile model results.

48-Year Recovery Standard for Spring/Summer Chinook

Alternative 4, Dam Breaching, is the only alternative under consideration that meets the 48-year recovery standards for the median model results. None of the median results of dam retention alternatives (e.g., Alternatives 1, 2 and 3) meet the 48-year recovery standards. However, the median results of the dam retention alternatives are relatively close to meeting the standard (e.g., within 2 percent to 5 percent). In addition, the 75th percentile model results exceed the recovery standard for all alternatives.

100-Year Survival Standard for Spring/Summer Chinook

All of the median results of the alternatives under consideration meet the 100-year survival standards, which as discussed above, require a 70 percent probability.

9.2.1.3 Fall Chinook Model Results

Table 9-2 presents the probability of each alternative meeting the NMFS jeopardy standards for fall chinook. This table also presents the median modeling results, which are considered the most likely outcome, as well as the 25th and 75th percentile model results, which bound the median result with a range from low to high.

Table 9-2. Probability of Attaining NMFS Jeopardy Standards for Fall Chinook Using Unweighted 1998 Model Results

		24-Year Survival	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1, Existing Conditions	0.85	0.78	0.97
Alternative 2, Maximum Transport of Juvenile Salmon	0.85	0.78	0.97
Alternative 3, Major System Improvements	0.81	0.69	0.95
Alternative 4, Dam Breaching	0.93	0.89	0.98
		48-Year Recovery	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1, Existing Conditions	0.22	0.15	0.56
Alternative 2, Maximum Transport of Juvenile Salmon	0.22	0.15	0.56
Alternative 3, Major System Improvements	0.28	0.17	0.63
Alternative 4, Dam Breaching	1.00	1.00	1.00
		100-Year Survival	
Action	**Median**	**25th percentile**	**75th percentile**
Alternative 1, Existing Conditions	0.83	0.71	0.98
Alternative 2, Maximum Transport of Juvenile Salmon	0.83	0.71	0.98
Alternative 3, Major System Improvements	0.78	0.64	0.95
Alternative 4, Dam Breaching	0.98	0.97	1.00

Source: Personal communication from NMFS

24-Year Survival Standard for Fall Chinook

All of the median results of the alternatives under consideration meet the 24th year survival standards, which as discussed above requires a 70 percent probability.

48-Year Recovery Standard for Fall Chinook

Alternative 4, Dam Breaching, is the only alternative under consideration that meets the 48th year recovery standards, using the median results from the 1998 PATH modeling process. None of the median results of dam retention alternatives met the 48th year recovery standards under the modeling conducted in 1998, which as discussed above, require a 50 percent result. In this case, the median results of the dam retention alternatives are not close to the recovery standard (e.g., within 22 percent to 28 percent), but the 75th percentile model results for these alternatives do exceed the recovery standard.

However, as noted at the end of this report, PATH 1999 model results show that dam retention alternatives meet the 48-year recovery standard.

100-Year Survival Standard for Fall Chinook

All of the median results of the alternatives under consideration meet the 100th year survival standards, which as discussed above, require a 70 percent probability.

9.2.1.4 1999 PATH Model Results

PATH is continuing to refine the model, using new information on key variables related to delayed mortality (the D factor), ocean conditions, and ocean harvests, among other variables. These modifications are having an affect on model results for fall chinook. According to Peters et al. (1999):

- "**All hydrosystem actions meet survival standards** (probabilities of exceeding survival escapement thresholds are greater than 0.7), regardless of what is assumed about the estuary/ocean survival rate of transported fish.
- **All drawdown actions meet recovery standards** (probabilities of exceeding recovery escapement thresholds are greater than 0.5) regardless of what is assumed about the estuary/ocean survival rate of transported fish. The Alternative 4, Dam Breaching, exhibited the most robust response across those uncertainties considered to date, and produced higher recovery probabilities (as well as higher average spawning escapements) than other actions. This conclusion is sensitive to assumptions about adult upstream survival.
- For each hypothesis about relative survival of transported fish, **there is a non-breaching action (actions which do not involve drawdowns of dams) that meets the recovery standard,** although there is no single non-breaching alternative option that meets recovery standards under all assumptions about the relative survival of transported fish. If transported fish are assumed to have high relative survival (i.e., high D), maximizing transportation will achieve recovery standards. If transported fish are assumed to have low relative survival (i.e., low D), then retaining current system configuration and allowing all smolts to migrate in-river achieves the

recovery standards. **Non-breaching actions are not as robust to the current level of uncertainty in relative survival of transported fish as are drawdown actions."**

Unfortunately, these results were reported too late to be included in the economic appendix.

9.2.2 Model Results

As mentioned above, the DREW Anadromous Fish Workgroup worked with NMFS and PATH staff to extrapolate the results of the PATH models from the weakest stocks to all spring/summer and fall chinook stocks as well as to steelhead stocks. The following section summarizes the results of this effort, which is based upon the 1998 model results. (Using the 1999 model results will increase the number of fish associated with the dam retention alternatives and decrease the differential in output between dam retention alternatives and the dam breaching alternative.)

As shown in Figure 9-1, the dam breaching alternative (using the 1998 PATH model results) generates approximately 30,000 more fish than is expected under Alternative 1, Existing Conditions, approximately 25 years after implementation of dam breaching. The DREW Anadromous Fish Workgroup estimates that the increase would consist of approximately 3,000 more steelhead, 14,000 more spring/summer chinook, and 13,000 more fall chinook. This level of increase represents an approximate doubling (e.g., 100 percent increase) of the wild fish escapement under the dam breaching alternative over the level expected under the base case (e.g., the base case reaches 35,000 fish during the same time period).

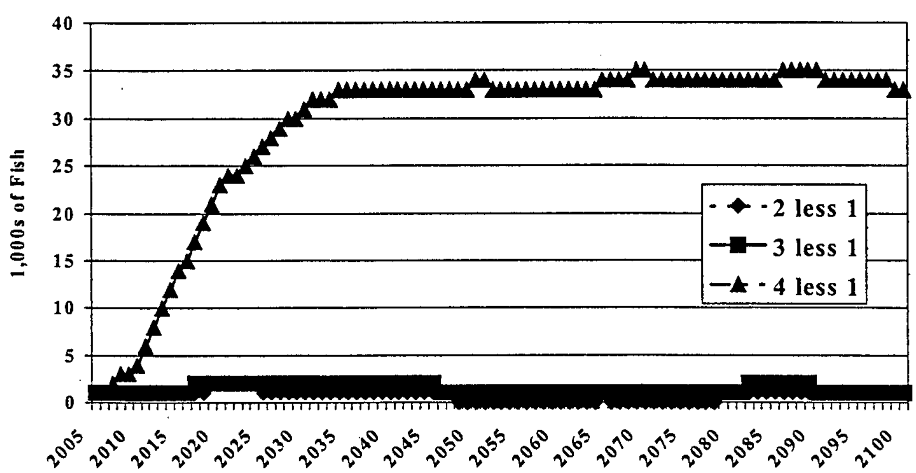

Figure 9-1. Net Increase in Fish over Base Case Conditions Using 1998 PATH Model Results (in 1,000s of Fish)

The dam retention alternatives (2 and 3) result in approximately 1,000 more fish than under the base case conditions, consisting mainly of spring/summer chinook.

The DREW Anadromous Fish Workgroup has not prepared revised estimates based upon the 1999 model results.

Harvest Standards

In addition to the survival and recovery standards, there may be harvest goals, which were not considered by PATH. These thresholds may be defined as a level of recovery which, in the judgment of the tribes, will lead to significantly increased tribal harvest, and commensurate significant improvement in cultural and material well being for tribal peoples (Meyer Resources, Inc.).

However, no measurable harvest goals were proposed during the course of the study. The tribal group has reported that the harvestable goals are met under Alternative 4, Dam Breaching, but not under other alternatives under the 1998 PATH model results. It is unknown whether the harvest goals would be met for dam retention alternatives using the 1999 PATH model results (see the Tribal Circumstance Chapter for more details).

9.3 Discussion of Net Cost Factors

Evaluation of environmental restoration and mitigation solutions requires an evaluation of monetary effects (or factors) in four general classes. When combined, these effects form the "net cost" information for cost effectiveness analyses, described in greater detail below.

9.3.1 Definition of Net NED Costs

Net costs are defined to include all NED effects, including:

- Implementation costs for the fish-related improvements (e.g., the construction and acquisition costs, annual costs for operation, maintenance, repair, replacement, rehabilitation, and monitoring, and Federal mitigation costs). These costs are presented in the implementation/avoided cost chapter of the appendix.
- Avoided costs, which include operations, maintenance, repair, replacement, and rehabilitation of existing infrastructure that would be avoided under alternative conditions (e.g., existing power systems, navigation locks, and other like costs that occur under the dam retention alternatives but not under the dam breaching alternative). These costs are also presented in the implementation/avoided cost chapter.
- NED costs, which are any existing costs that would be incurred as a result of implementing the dam breaching alternative, notably:
    - additional costs to provide power by the next least costly form of power generation (described in the hydropower chapter of the appendix),
    - additional transportation costs to shift barge-transported commodities to other truck, rail and barge systems (described in the transportation chapter of the appendix), and,
    - additional construction/O&M costs for irrigation and water supply systems (described in the water supply section of this report).
- NED Benefits, which are any existing benefits that would accrue as a result of implementing alternatives, notably:

- additional recreation benefits from drawdown conditions for anglers from enhanced fisheries and to users of the free flowing river (described in the recreation chapter of the appendix), and,
- additional commercial fishing benefits in the river and ocean, and recreation benefits occurring outside of the lower Snake River system (described in Section 3.5 of this appendix, Anadromous Fish).

Net NED costs are defined to equal implementation costs plus avoided costs, plus NED costs less NED benefits.

9.3.2 Presentation of Annual Results (Using PATH 1998 Model Results)

Table 9-3 presents the low, most likely, and high net NED annualized costs, as defined in the previous sections. Again, all comparative estimates are net of the base case.

Under the most likely case and a 6.875 percent discount rate:

- Alternative 2, Maximum Transport, is $14.1 million less costly per year than the existing conditions,
- Alternative 3, Major System Improvements, is $4.8 million less costly per year than the existing conditions and,
- Alternative 4, Dam Breaching, is $246.5 million more costly than the existing conditions annually over the 100-year study period. Alternative 4 is between $220.8 and $276.6 million more costly on an annual basis, compared for the existing conditions.

Table 9-3. Annualized Net Cost Comparison (1998 Dollars) ($1,000s)

Rate	Most Likely ($)	Low ($)	High ($)
@6.875 percent			
Alternative 2 less Alternative 1	(14,147)	(15,366)	(11,355)
Alternative 3 less Alternative 1	(4,810)	(6,501)	1,743
Alternative 4 less Alternative 1	246,474	220,758	276,569
@4.75 percent			
Alternative 2 less Alternative 1	(13,172)	(14,425)	(10,236)
Alternative 3 less Alternative 1	(6,268)	(7,876)	(78)
Alternative 4 less Alternative 1	245,467	220,378	274,192
@0.0 percent			
Alternative 2 less Alternative 1	(10,281)	(11,116)	(8,095)
Alternative 3 less Alternative 1	(7,978)	(8,944)	(4,400)
Alternative 4 less Alternative 1	208,810	184,439	235,284

Source: Implementation/Avoided Cost chapter (Tables 3.8-4 and 3.8-5), Hydropower chapter (Table 3.4-22), Transportation chapter (Table 3.3-34), Water Supply chapter (Table 3.4-17), Recreation chapter (Tables 3.4-8), and the Anadromous Fish chapter (Table 3.5-3).

Under the most likely case and a 4.75 percent discount rate, Alternative 2 is $13.2 million less costly, Alternative 3 is $6.2 million less costly and Alternative 4 is $245.5 million more costly than the existing conditions annually over the 100-year study period.

Under the most likely case and a 0.0 percent discount rate, Alternative 2 is $10.3 million less costly, Alternative 3 is $8.0 million less costly and Alternative 4 is $208.8 million more costly than the existing conditions annually over the 100-year study period.

9.4 Cost Effectiveness Comparisons

The following section provides a graphical and tabular comparison of the net NED costs and biological effectiveness for spring/summer chinook and fall chinook, separately, taking into account both the NMFS jeopardy standards and the estimated number of fish associated with each alternative. There are no PATH/NMFS estimates of the combined probabilities of meeting the jeopardy standards for both spring/summer and fall chinook salmon.

The cumulative costs are calculated by multiplying the annual costs by the number of years of the applied standard. As an example, Alternative 4, Dam Breaching, costs $5.9 billion to administer over a 24-year period (e.g., 24 years times the annual cost of $246,474,000 equals $5,915,367,000). The total number of fish is calculated in a similar manner. As an example, Alternative 4, Dam Breaching, results in 168,612 more fish during the first 24-year period than does Alternative 1, Existing Conditions.

The cost effectiveness assessment considers two different but related perspectives to determine the least costly means of meeting the NMFS jeopardy standards:

- The first evaluation considers the cost to attain an additional percentage of the jeopardy standards.
- The second evaluation considers the cost per additional fish.

9.4.1 Cost Effectiveness Assessment 1—All Costs Applied to Spring/Summer Chinook

Figures 9-2 through 9-4 and Table 9-4 present a comparison of the net NED cost and net biological effectiveness to achieve the NMFS' jeopardy standards for spring/summer chinook for the various alternatives under consideration. This cost effectiveness assessment considers the entire cost of the alternatives applied to spring/summer chinook.

9.4.1.1 24-Year Survival Standard for Spring/Summer Chinook

As noted above, under the most likely (median) conditions, none of the alternatives meet the 24-year survival standard for spring/summer chinook. However, all alternatives are relatively close to the goal (e.g., within 3 percent for Alternative 1, 5 percent for Alternative 2, 4 percent for Alternative 3, and 1 percent for Alternative 4) (see Table 9-1.).

The cumulative costs associated with Alternatives 2 and 3 are lower than those under Alternative 1, resulting in net savings. However, the probability of meeting the 24-year survival standard is also lower under these alternatives than under Alternative 1. Each percentage of improved survival is estimated to cost approximately $169.8 million under Alternative 2, Maximum Transport, and $115.5 million under Alternative 3, Major System Improvement, over the 24-year period (see Table 9-4).

There is only a marginal improvement associated with selecting Alternative 4, Dam Breaching, over Alternative 1, Existing Conditions, but this occurs at a high cost. Each additional percentage of survival attained in moving from Alternative 1, Existing Conditions, to Alternative 4, Dam Breaching, is expected to cost approximately $3.0 billion in cumulative costs over the 24-year period. Under Alternative 4, each additional spring/summer chinook is estimated to cost $35,000 over the 24-year period, using the 1998 PATH model results (see Figure 9-2 and Table 9-4).

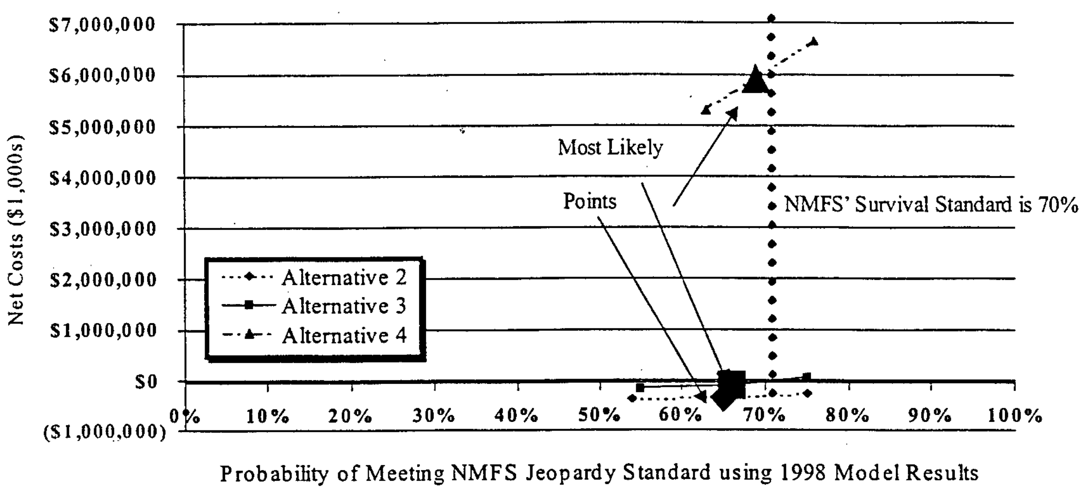

Figure 9-2. Net Cost & Biological Effectiveness Comparison for Meeting the NMFS' 24-Year Survival Standards for Spring/Summer Chinook Using 1998 PATH Model Results

Table 9-4. Incremental Comparison of Net Costs (in $1,000s) and Biological Effectiveness for Spring/Summer Chinook (1998 Dollars)

Standard by Alternative	Cumulative Cost ($)	Percent ($)	Cost per percent ($)	Total Fish	Cost per Fish ($)
24-Year Standard					
Alternative 2 less Alternative 1	(339,522)	(2.0)	169,761	25,699	(13)
Alternative 3 less Alternative 1	(115,448)	(1.0)	115,448	40,934	(3)
Alternative 4 less Alternative 1	5,915,367	2.0	2,957,684	168,612	35
48-Year Standard					
Alternative 2 less Alternative 1	(679,045)	(3.0)	226,348	46,046	(15)
Alternative 3 less Alternative 1	(230,896)	(2.0)	115,448	78,012	(3)
Alternative 4 less Alternative 1	11,830,735	36.0	328,632	556,370	21
100-Year Standard					
Alternative 2 less Alternative 1	(1,414,677)	(1.0)	1,414,677	82,855	(17)
Alternative 3 less Alternative 1	(481,034)	-	NM	78,012	(6)
Alternative 4 less Alternative 1	24,647,365	10.0	2,464,736	1,419,466	17

Note: This table uses 1998 PATH model results; 1999 model results are not available in the same format.
Source: BST Associates using data from the Economic Appendix, NMFS and PATH
NM = Not met.

9.4.1.2 48-Year Recovery Standard for Spring/Summer Chinook

Only the dam breaching alternative meets the 48-year recovery standard using the 1998 PATH model results. The dam retention alternatives are relatively close (e.g., within 2 percent to 5 percent) of meeting the recovery standard under the median values. All alternatives attain the standard under the high-end of the probability distribution (e.g., at the 75th percentile).

The costs associated with Alternatives 2 and 3 are lower than those under Alternative 1, resulting in a net savings. However, the probability of meeting the NMFS 48-year standard is lower under these alternatives than under Alternative 1. Each percentage of improved survival is estimated to cost $226.3 million under Alternative 2 and $115.5 million under Alternative 3 (see Table 9-4.)

Each additional percentage attained from moving from Alternative 1, Existing Conditions (48 percent probability of attaining recovery) to Alternative 4, Dam Breaching (84 percent probability of recovery), is expected to cost $328.6 million over the 48-year period. Each fish attained by moving from Alternative 1, Existing Conditions, to Alternative 4, Dam Breaching is expected to cost approximately $21,000 per fish (see Figure 9-3 and Table 9-4).

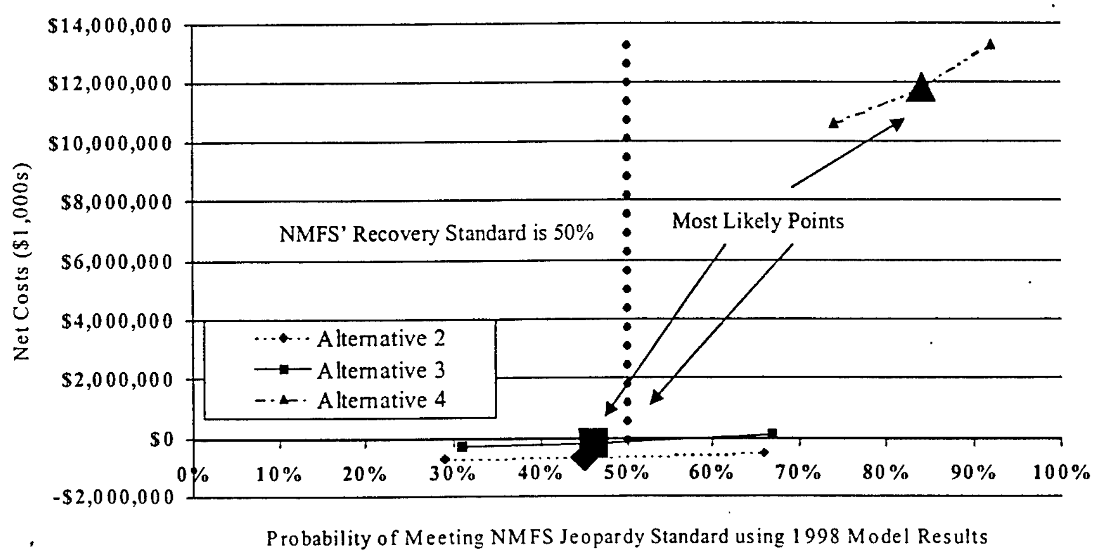

Figure 9-3. Net Cost & Biological Effectiveness Comparison for Meeting the NMFS' 48-Year Recovery Standards for Spring/Summer Chinook Using 1998 PATH Model Results

9.4.1.3 100-Year Survival Standard for Spring/Summer Chinook

All alternatives meet the 100-year survival standard (see Figure 9-4 and Table 9-1).

Attaining an additional percentage of survival under Alternative 2 would cost approximately $1.4 billion. Alternatives 1 and 3 have the same median probability of meeting the 100-year standard.

Each additional percentage attained from moving from Alternative 1, Existing Conditions (79 percent probability of attaining recovery) to Alternative 4, Dam Breaching (89 percent probability of recovery) is expected to cost $2.5 billion over the 100-year period. Each fish attained by moving from Alternative 1, Existing Conditions, to Alternative 4, Dam Breaching is expected to cost approximately $17,000 per fish (see Figure 9-4 and Tables 9-1 and 9-4).

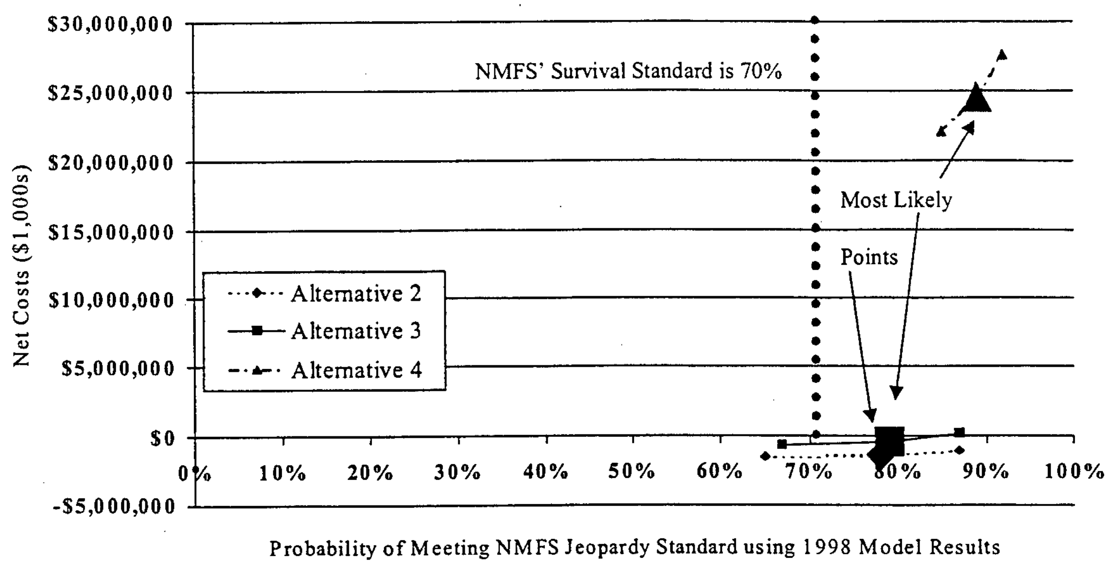

Figure 9-4. Net Cost & Biological Effectiveness Comparison for Meeting the NMFS' 100-Year Survival Standards for Spring/Summer Chinook Using 1998 PATH Model Results

9.4.2 CE Assessment 2—All Costs Applied to Fall Chinook

Figures 9-5 through 9-7 and Table 9-5 present a comparison of the net cost and biological effectiveness to achieve the NMFS' jeopardy standards for fall chinook for the various alternatives under consideration. This cost effectiveness assessment considers the entire cost of the alternatives applied to fall chinook.

9.4.2.1 24-Year Survival Standard for Fall Chinook

Under the most likely (median) conditions, all of the alternatives meet the 70 percent survival standard on the 24th-year. The probability of success is the same for Alternatives 1 and 2. Hence there is no cost differential per percentage gained between these alternatives. However, Alternative 2 is $339.5 million less costly than Alternative 1.

The increase in one percentage probability in moving from Alternative 1, Existing Conditions, to the Alternative 3, Major System Improvements, is expected to cost $28.8 million over the 24-year period (see Figure 9-5 and Table 9-5)

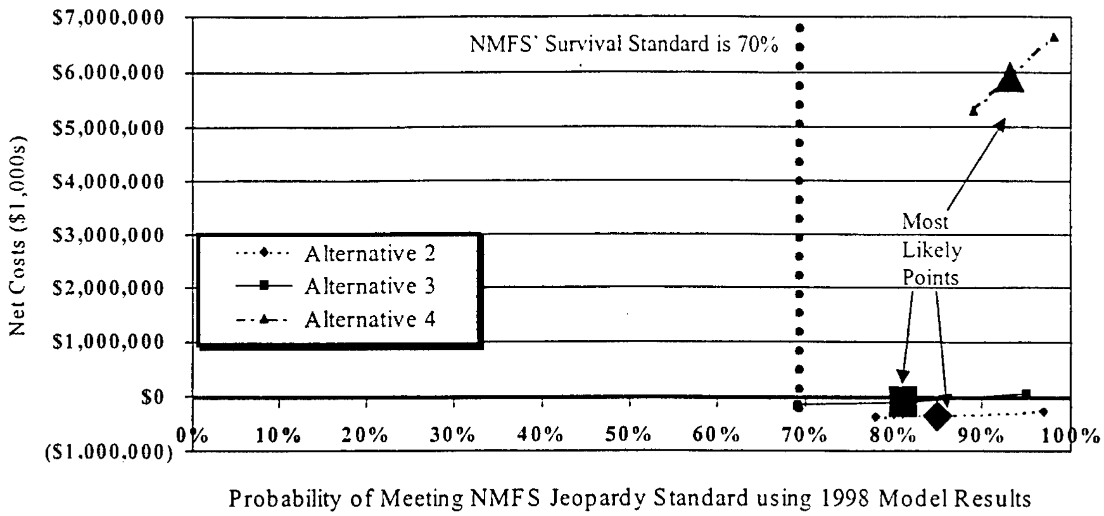

Figure 9-5. Net Cost & Biological Effectiveness Comparison for Meeting the NMFS' 24-Year Survival Standards for Fall Chinook Using 1998 PATH Model Results

Table 9-5. Incremental Comparison of Net Costs (in $1,000s) and Biological Effectiveness for Fall Chinook Using 1998 PATH Model Results (1998 Dollars)

Standard by Alternative	Cumulative Cost ($)	Percent	Cost per percent ($)	Total Fish	Cost per Fish ($)
24-Year Standard					
Alternative 2 less Alternative 1	(339,522)	-	-	-	-
Alternative 3 less Alternative 1	(115,448)	(4.0)	28,862	4,524	(26)
Alternative 4 less Alternative 1	5,915,367	8.0	739,421	205,443	29
48-Year Standard					
Alternative 2 less Alternative 1	(679,045)	-	-	-	-
Alternative 3 less Alternative 1	(230,896)	6.0	(38,483)	11,735	(20)
Alternative 4 less Alternative 1	11,830,735	78.0	151,676	524,959	23
100-Year Standard					
Alternative 2 less Alternative 1	(1,414,677)	-	-	-	-
Alternative 3 less Alternative 1	(481,034)	(5.0)	96,207	25,444	(19)
Alternative 4 less Alternative 1	24,647,365	15.0	1,643,158	1,207,274	20

Note: This table uses 1998 PATH model results, 1999 model results are not available in a similar format.
Source: BST Associates using data from the Economic Appendix, NMFS and PATH

The increase in one percentage probability in Alternative 1, Existing Conditions, to the Alternative 4, Dam Breaching is expected to cost $739.4 million over the 24-year period. Each additional fish gained by dam breaching is estimated to cost $29,000 per fish (see Figure 9-5 and Table 9-5).

9.4.2.2 48-Year Recovery Standard for Fall Chinook

Only the dam breaching alternative meets the 48-year recovery standard using the 1998 PATH model results. The dam retention alternatives are not close to meeting this recovery standard (between 22 percent to 28 percent away from the 50 percent recovery standard), using the 1998 model results.

The benefit in moving from Alternative 1, Existing Conditions, to Alternative 3, Major System Improvements, is expected to save $38.5 million over the 48-year period (see Figure 9-5 and Table 9-4).

Each additional percentage of survival attained from moving from Alternative 1 (22 percent probability of attaining recovery) to Alternative 4 (100 percent probability of recovery) is expected to cost $151.7 million per year over the 48-year period. Each fish attained by moving from Alternative 1 to Alternative 3 is expected to cost approximately $23,000 per fish (see Figure 9-6 and Tables 9-2 and 9-5).

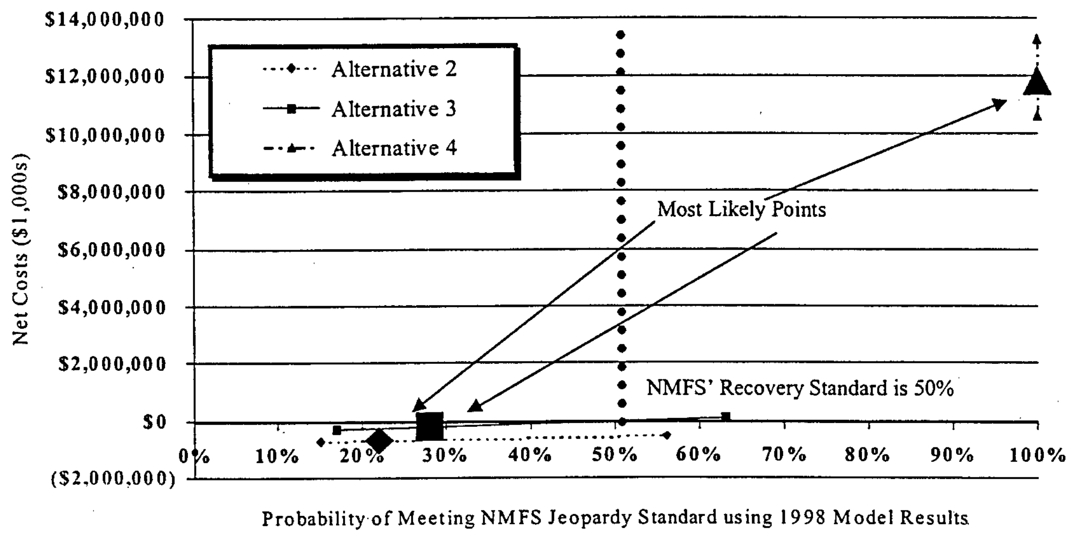

Figure 9-6. Net Cost & Biological Effectiveness Comparison for Meeting the NMFS' 48-Year for Fall Chinook Using 1998 PATH Model Results

9.4.2.3 100-Year Survival Standard for Fall Chinook

All alternatives meet the 100-year survival standard (see Figure 9-7 and Table 9-2).

The benefit in moving from Alternative 1, Existing Conditions, to Alternative 3, Major System Improvements, is expected to cost $96.2 million over the 100-year period (see Figure 9-5 and Table 9-5).

Each additional percentage of survival attained from moving from Alternative 1 to Alternative 4 is expected to cost $1.6 billion per year over the 100-year period. Each fish attained by moving from Alternative 1 to Alternative 4 is expected to cost approximately $20,000 per fish (see Figure 9-7 and Table 9-5).

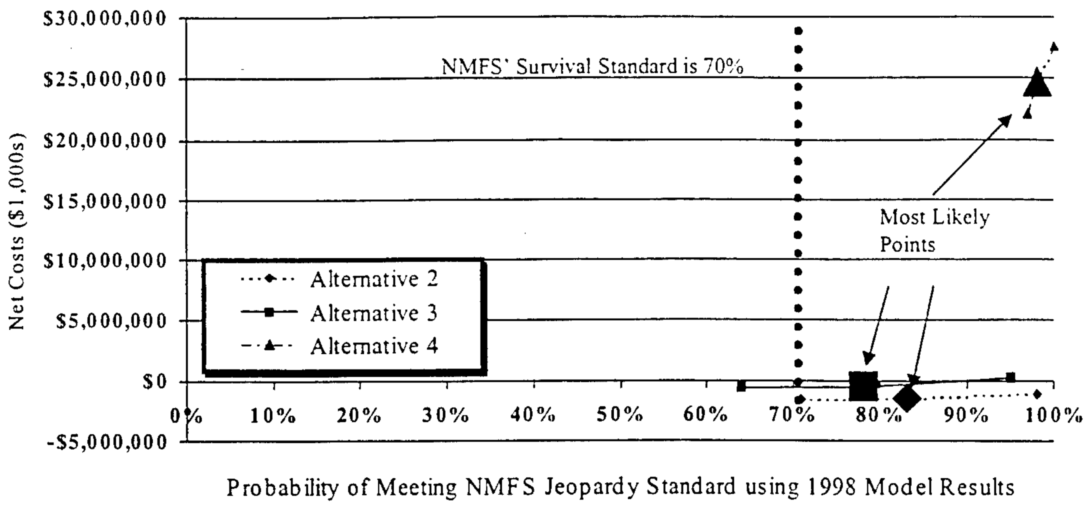

Figure 9-7. Net Cost & Biological Effectiveness Comparison for Meeting the NMFS' 100-Year Survival Standards for Fall Chinook Using 1998 PATH Model Results

9.4.3 CE Assessment 3—Costs Applied to all Fish

A comparison of the net cost and biological effectiveness to achieve the NMFS jeopardy standards across spring/summer and fall chinook and steelhead for the various alternatives under consideration is presented in Table 9-6. This cost effectiveness assessment spreads the cost of the alternatives to all fish, as determined by the anadromous fish working group. As mentioned previously, there is no combined probability associated with meeting the NMFS standards across all impacted species.

9.4.3.1 24-Year Survival Standard for all Fish

Alternatives 2 and 3 are estimated to generate more fish than Alternative 1 at a reduced cost. The savings from choosing these alternatives is estimated to be $11,000 and $3,000 per fish over the 24-year survival standard, for each respective alternative. The additional cost of moving from Alternative 1, Existing Conditions, to Alternative 4, Dam Breaching, is estimated to be $15,000 per fish over the 24-year period (see Figure 9-5 and Table 9-6).

9.4.3.2 48-Year Recovery Standard for all Fish

The savings from choosing Alternatives 2 or 3 is estimated to be $14,000 and $3,000 per fish over the 48-year recovery standard, respectively. The additional cost of moving from Alternative 1, Existing Conditions, to Alternative 4, Dam Breaching, is estimated to be $10,000 per fish over the 48-year period (see Figure 9-5 and Table 9-6).

9.4.3.3 100-Year Survival Standard for all Fish

The savings from choosing Alternatives 2 or 3 is estimated to be $18,000 and $4,000 per fish over the 100-year survival standard, respectively. The additional cost of moving from Alternative 1, Existing Conditions, to Alternative 4, Dam Breaching, is estimated to be $8,000 per fish over the 100-year period (see Figure 9-5 and Table 9-6).

Table 9-6. Incremental Comparison of Net Costs (in $1,000s) and Biological Effectiveness for Spring/Summer and Fall Chinook and for Steelhead using 1998 PATH Model Results, as Extrapolated by the DREW Anadromous Fish Workgroup (1998 dollars)

Standard by Alternative	Cumulative Cost ($)	Total Fish ($)	Cost per Fish ($)
24-Year Standard			
Alternative 2 less Alternative 1	(339,522)	29,757	(11)
Alternative 3 less Alternative 1	(115,448)	38,936	(3)
Alternative 4 less Alternative 1	5,915,367	403,115	15
48-Year Standard			
Alternative 2 less Alternative 1	(679,045)	48,157	(14)
Alternative 3 less Alternative 1	(230,896)	72,220	(3)
Alternative 4 less Alternative 1	11,830,735	1,188,900	10
100-Year Standard			
Alternative 2 less Alternative 1	(1,414,677)	78,634	(18)
Alternative 3 less Alternative 1	(481,034)	131,429	(4)
Alternative 4 less Alternative 1	24,647,365	2,915,720	8

Note: This table uses 1998 PATH model results; 1999 model results are not available in a similar format.
Source: BST Associates using data from the Economic Appendix, NMFS and PATH

9.5 Conclusions

9.5.1 Biological Considerations

9.5.1.1 1998 Model Results

None of the alternatives meets all of the jeopardy standards using 1998 PATH model results.

Alternative 4, Dam Breaching, **comes the closest** to meeting all of the jeopardy standards for both spring/summer and fall chinook (e.g., five out of six standards).

The dam retention alternatives **come relatively close** to meeting all of the jeopardy standards, with the exception of the 48-year recovery standard for fall chinook.

9.5.1.2 1999 Model Results

As discussed previously, PATH is continuing to refine the model, using new information on key variables related to delayed mortality (the D factor), ocean conditions, and ocean harvests, among other variables. These modifications are having an affect on model results for fall chinook, in the following ways:

- All alternatives meet the 24-year and 100-year survival standards.
- All drawdown actions meet the 48-year recovery standard.

- Non-breaching actions (e.g., Alternatives 1, 2 and 3) all meet the 48-year recovery standard but they are not considered as robust to the current level of uncertainty in relative survival of transported fish as is Alternative 4, Dam Breaching.

Unfortunately, the 1999 model results were reported too late to be included in the economic appendix.

9.5.2 Cost Effectiveness Analysis

The following conclusions **use the 1998 model results**, which suggested a larger variation in output between dam retention and dam breaching alternatives. **Model results from 1999 suggest that the difference is much narrower between these alternatives than stated in the 1998 model results.** As a consequence, the cost effectiveness results based on 1998 model results *over-state the benefits from dam breaching* relative to dam retention.

9.5.2.1 Cost Effectiveness Assessment 1—Costs Applied to Spring/Summer Chinook

There is little difference between the dam retention alternatives and the dam breaching alternative with respect to meeting the NMFS jeopardy standards for spring/summer chinook. As a result, dam breaching creates little additional biological output using 1998 model results but is significantly more costly. The additional cost of choosing Alternative 4, Dam Breaching, as opposed to Alternative 1, Existing Conditions, is estimated at $17,000 to $35,000 per fish, depending on the year under consideration (e.g., the cost decreases as the number of years increases).

9.5.2.2 Cost Effectiveness Assessment 2—Costs Applied to Fall Chinook

Under the 1998 model results, the dam retention alternatives meet the 24-year and 100-year survival standards but are not close to meeting the 48-year recovery standard. The additional cost of choosing Alternative 4, Dam Breaching, as opposed to Alternative 1, Existing Conditions, is estimated at $20,000 to $29,000 per fish, depending on the year under consideration (e.g., the cost decreases as the number of years increases).

Since dam retention alternatives meet or come close to meeting the NMFS jeopardy standards for spring/summer chinook but not for fall chinook using the 1998 model results, dam breaching could be considered preferred for fall chinook but unnecessary for spring/summer chinook.

9.5.2.3 Cost Effectiveness Assessment 3—Costs Applied to all Fish

Alternatives 2 and 3 are estimated to generate more fish than Alternative 1 at a reduced cost. The savings from choosing Alternative 2 is estimated to range between $11,000 and $18,000 per fish, depending upon the number of years under consideration. The savings from choosing Alternative 3 is estimated to range between $3,000 and $8,000 per fish, depending upon the number of years under consideration.

The additional cost of choosing Alternative 4, Dam Breaching, is estimated to be between $8,000 and $15,000 per fish, depending upon the number of years under consideration.

9.5.2.4 Implications of the 1999 Model Results

The 1999 model results have the following qualitative implications:

- Biological output—the number of fish associated with dam retention alternatives will increase and the difference in the number of fish, comparing dam retention and dam breaching alternatives, will decrease.
- NED costs—there will be no change in the NED cost estimates since they are based on moving to alternative and more costly systems (e.g., to produce power, transport commodities etc.) and are, thus, not sensitive to differences in biological output.
- NED benefits—the estimated benefits from commercial and recreational fishing associated with the dam breaching alternative as compared with the dam retention alternatives will decrease because the incremental fish output is smaller between alternatives with the 1999 model results.
- Although the 1999 model results are not available in a similar format as those prepared in 1998, the biological benefits of the dam retention alternatives improve markedly while the biological benefits of the dam breaching alternative do not change markedly. This new information suggests that all of the NMFS jeopardy standards can be met under dam retention alternatives at much lower cost than under dam breaching.

9.5.3 Unresolved Issues

The Economics Appendix was prepared before the PATH 1999 model results were available. The major unresolved issue in this chapter is updating the data results that would be expected to change as a result of the 1999 PATH model results. As described above, this includes:

- Relative biological outputs, including the PATH ranges of probabilities (from low to high and median results) and the DREW Anadromous Fish Workgroup economic extrapolations to the entire ESU stocks and to steelhead,
- Revised commercial and recreational NED benefits.

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10. Summary of Effects

10.1 Introduction

The purpose of this section is to present a balanced display of overall benefits and costs associated with each resource area across each alternative. The summary presents both the monetary and non-monetary effects of the national and regional analyses developed for this Feasibility Report.

It should be emphasized that the national and regional displays are distinct accounting stances and cannot be added or subtracted from each other. With the exception of selected monetary estimates noted by an asterisk, all estimates are presented net of Alternative 1, Existing Conditions.

10.2 National Benefits and Costs

The first section presents a comparison of national benefits and costs, including:

- Biological impacts associated with each alternative
- National economic development (NED) costs
- National economic development (NED) benefits.

10.2.1 Biological Benefits

Table 10.1 presents a comparison of alternative results based upon data provided by NMFS and PATH using 1998 model results. None of the alternatives meets all of the jeopardy standards using 1998 PATH model results. Alternative 4, Dam Breaching, comes the closest to meeting all of the jeopardy standards for both spring/summer and fall chinook (e.g., this alternative meets 5 out of 6 standards). The dam retention alternatives come relatively close to meeting all of the jeopardy standards, with the exception of the 48-year recovery standard for fall chinook.

However, PATH is continuing to refine the model, using new information on key variables related to delayed mortality (the D factor), ocean conditions, and ocean harvests, among other variables. These modifications are having an affect on model results for fall chinook. According to the Peters et al., 1999:

- "All hydrosystem actions meet survival standards (probabilities of exceeding survival escapement thresholds are greater than 0.7), regardless of what is assumed about the estuary/ocean survival rate of transported fish.
- All drawdown actions meet recovery standards (probabilities of exceeding recovery escapement thresholds are greater than 0.5) regardless of what is assumed about the estuary/ocean survival rate of transported fish. Alternative 4, Dam Breaching, exhibited the most robust response across those uncertainties considered to date, and produced higher recovery probabilities (as well as higher average spawning escapements) than other actions. This conclusion is sensitive to assumptions about adult upstream survival.
- For each hypothesis about relative survival of transported fish, there are non-breaching actions (actions which do not involve drawdowns of dams) that meets the recovery standard, although there is no single non-breaching alternative option that meets recovery standards under all assumptions about the relative survival of transported fish. If transported fish are assumed to

have high relative survival (i.e., high D), maximizing transportation will achieve recovery standards. If transported fish are assumed to have low relative survival (i.e.. low D), then retaining current system configuration and allowing all smolts to migrate in-river achieves the recovery standards. Non-breaching actions are not as robust to the current level of uncertainty in relative survival of transported fish as are drawdown actions." (Page 8)

The 1999 model results are not available in the same format as the 1998 model results reported in Table 10-1.

Table 10-1. Ability to Meet the NMFS Jeopardy Standards for Survival and Recovery Based Upon 1998 PATH Model Results (Median Values Presented)

Biological Benefits	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Spring/Summer Chinook				
Survival in 24th year (standard is 0.70)	0.67	0.65	0.66	0.69
Recovery in 48th Year (standard is 0.50)	0.48	0.45	0.46	0.84
Survival in 100th year (standard is 0.70)	0.79	0.78	0.79	0.89
Fall Chinook				
Survival in 24th year (standard is 0.70)	0.85	0.85	0.81	0.93
Recovery in 48th Year (standard is 0.50)	0.22	0.22	0.28	1.00
Survival in 100th Year (standard is 0.50)	0.83	0.83	0.78	0.98

Source: NMFS, PATH

10.2.2 NED Costs

NED costs include the following cost categories:

- Implementation costs for the fish-related improvements (e.g., the construction and acquisition costs, annual costs for operation, maintenance, repair, replacement, rehabilitation, and monitoring and Federal mitigation costs). For more detail, the reader is referred to the chapter on implementation and avoided costs.
- NED Costs, which are any existing National Economic Development (NED) costs that would be incurred as a result of implementing the dam breaching alternative, notably:
  - additional costs to provide power by the next least costly form of power generation (described in the hydropower chapter)
  - additional transportation costs to shift barge-transported commodities to other truck, rail and barge systems (described in the transportation chapter)
  - additional construction/O&M costs for irrigation and water supply systems (described in the water supply chapter).

All costs presented in Table 10-2 are net of Alternative 1, Existing Conditions. NED costs associated with Alternative 2, Maximum Transport of Juvenile Salmon, and Alternative 3, Major System Improvements, are lower than under base case conditions, by $12.0 million and $2.6 million, respectively at a discount rate of 6 7/8 percent. The NED costs associated with Alternative 4, Dam Breaching, are estimated to be $359 million higher than under the base case conditions per year for 100 years, under the same discount rate.

Table 10-2. Summary of NED Costs Net of the Base Case (1998 Dollars) ($1,000s)

Description of NED Costs	Alternative 2	Alternative 3	Alternative 4
Implementation Costs			
@6.875%	3,457	(5,931)	(48,787)
@4.75%	2,556	(4,376)	(35,498)
@0.0%	663	(1,390)	(8,298)
Power			
@6.875%	8,500	8,500	(271,000)
@4.75%	8,500	8,500	(267,500)
@0.0%	8,000	8,000	(263,500)
Transportation			
@6.875%	-	-	(24,034)
@4.75%	-	-	(25,249)
@0.0%	-	-	(28,330)
Irrigation/Water Systems			
@6.875%	-	-	(15,424)
@4.75%	-	-	(10,746)
@0.0%	-	-	(2,241)
Total			
@6.875%	11,957	2,569	(359,245)
@4.75%	11,056	4,124	(338,993)
@0.0%	8,663	6,610	(302,368)

Source: Economics Appendix chapters

Using the 1999 NMFS/PATH results, which as discussed above will increase the biological output associated with the dam retention alternatives, will not impact net NED costs because these cost estimates are not sensitive to biological output.

10.2.3 NED Benefits

NED benefits include the following cost categories:

- Avoided costs, which include operations, maintenance, repair, replacement, rehabilitation of existing infrastructure that would be avoided under alternative conditions (e.g., existing power systems, navigation locks, and other like costs that occur under the dam retention alternatives but not under the dam breaching alternative). These costs, which are presented in the implementation/avoided cost chapter, are treated as a benefit in the following table because they can be avoided under the dam breaching alternative.
- NED Benefits, which include any existing National Economic Development (NED) benefits that could accrue as a result of implementing alternatives, notably:
    - additional recreation benefits from drawdown conditions for anglers from enhanced fisheries and to users of the free flowing river (described in the recreation chapter)

- additional commercial fishing benefits in the river and in the ocean and recreation benefits occurring outside of the Lower Snake River system (described in the anadromous fish chapter).

All benefits presented in Table 10-3 are net of Alternative 1, Existing Conditions. NED benefits associated with Alternative 2, Maximum Transport of Juvenile Salmon, and Alternative 3, Major System Improvements, are higher than under base case conditions by $2.2 million, at a discount rate of 6 7/8 percent. The NED benefits associated with Alternative 4, Dam Breaching, are estimated to be $113 million higher than under the base case conditions per year for 100 years, under the same discount rate.

Table 10-3. Summary of NED Benefits Net of the Base Case (1998 Dollars) ($1,000s)

Description of NED Benefits	Alternative 2	Alternative 3	Alternative 4
Avoided Costs			
@6.875%	-	-	29,178
@4.75%	-	-	29,343
@0.0%	-	-	29,050
Recreation			
@6.875%	2,030	2,080	82,000
@4.75%	1,940	1,970	62,120
@0.0%	1,420	1,180	61,022
Commercial Fishing			
@6.875%	160	161	1,593
@4.75%	176	174	2,064
@0.0%	198	188	3,486
Total NED Benefits			
@6.875%	2,190	2,241	112,771
@4.75%	2,116	2,144	93,527
@0.0%	1,618	1,368	93,558

Source: Economics Appendix chapters

Using the 1999 NMFS/PATH results, which as discussed above will increase the biological output associated with the dam retention alternatives, will not impact avoided costs since they are based on the costs of operating the existing systems and are not sensitive to biological output. However, using the 1999 model results will reduce NED benefits associated with Alternative 4, Dam Breaching, because relatively more fish are projected for the dam retention alternatives resulting in a smaller biological difference between the dam retention and dam breaching alternatives.

10.3 Tribal Benefits and Costs

This section presents a summary of tribal effects. The estimated increase in tribal harvest is based upon 1998 model results. As with NED benefits, using the 1999 model results will increase the harvest for Alternatives 1, 2 and 3 and reduce the difference between dam retention and dam breaching alternatives.

The Tribal Circumstances and Perspectives Report asserts that Alternatives 1 and 2 offer limited hope of salmon recovery within a timeframe considered reasonable by the five represented tribes. The report does not address Alternative 3, but the impacts for this alternative are likely closely match with those for Alternative 2. There would be no change in tribal land use under any of these alternatives.

According to the Tribal Circumstances and Perspectives Report, Alternative 4, Dam Breaching, would produce 2.4 times more tribal harvest of Snake River wild salmon and steelhead stocks compared to Alternative 1 (2.6 times more harvest than Alternative 2). At the 50-year benchmark, estimated tribal wild and hatchery harvest would increase by about 1.7 million pounds. The Tribal Circumstances and Perspectives Report concludes that only this alternative would redirect river actions toward significant improvement of the cultural and material circumstances of the tribes.

Approximately 14,000 acres of previously inundated land would be exposed under Alternative 4. The Tribal Circumstances and Perspectives Report states that the tribes would benefit greatly from implementation of this alternative by gaining access to lands once used for cultural, material, and spiritual purposes.

10.4 Passive Use Value Estimates

This section presents a summary of the passive use (or existence) values for salmon recovery and survival and for the creation of a free-flowing river. Economists recognize that there is a benefit associated with knowing that the resource exists even if no use is made of it. There are, however, disagreements about how to measure passive use values. The Economic Appendix used a benefit transfer approach. The reader is referred to Passive Use Values chapter of this appendix for more information. It should be noted that passive use values are not considered to be NED benefits.

The passive use values associated with salmonid recovery and survival in the Snake River were estimated to range from $66 million to $879 million per year, with a middle range between $142 and $508 million per year.

The passive use value of a free flowing Snake River was estimated at $420 million per year.

The passive use values for salmon recovery and survival are based upon the 1998 model results on a per fish basis. As with NED benefits and tribal harvests, using the 1999 model results will reduce the difference between dam retention and dam breaching alternatives and hence will decrease the difference in passive use values for salmon between dam retention and dam breaching alternatives. However, the passive use values associated with the free flowing river will not change because they are not sensitive to biological output.

10.5 Regional Benefits and Costs

The Regional Economic Development (RED) account addresses regional economic impacts in terms of jobs and income resulting from the alternatives under consideration. Impacts on employment and income include direct, indirect (e.g., inter-firm purchases) and induced (e.g., purchases by employees of affected firms) effects. The job totals reported below are estimates of total impacts and include both full- and part-time employment.

10.5.1 Regional Impacts Associated with Alternatives 2 and 3

Regional impacts under Alternatives 2 and 3 are expected to be relatively minor and limited to those associated with changes in implementation and avoided cost.

10.5.2 Regional Impacts Associated with Alternative 4 (RED)

The regional economic analysis developed for this study addresses the regional economic impacts of changes in spending projected by various DREW workgroups. These impacts, evaluated in terms of business sales, employment, and income, were estimated using input-output models, which model the interactions among different sectors of the economy. Eight models were constructed to address the potential regional effects associated with the alternatives. Models were developed for Washington, Oregon, Idaho, and Montana, three subregions—the downriver, reservoir, and upriver subregions, and the lower Snake River study area, which consists of the three subregions. In addition, the DREW Anadromous Fish Workgroup estimated the economic impacts of changes in anadromous fish harvests. These impacts were evaluated for the Pacific Northwest states, Alaska, and British Columbia, Canada.

Construction activities resulting directly and indirectly from breaching of the four lower Snake River dams would generate increased business sales of $2,263 million, 20,790 temporary jobs, and $676.7 million in personal income in the lower Snake River study area. These changes would occur within ten years of dam breaching and would fluctuate from year-to-year. In the long run, the lower Snake River study would experience a net decrease in business sales of $33.7 million, a loss of 711 jobs, and decrease of $46.1 million in personal income. Short- and long-term changes lower Snake River study area employment are presented by resource area and study region in Tables 10-4 and 10-5.

Table 10-4. Short-Term Employment Effects (Jobs)1/

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area2/
1995 Employment	75,081	92,535	151,124	318,740
Power Plant Construction3/	0	0	5,572	5,572
Transmission Line Construction	0	0	2,080	2,080
Rail Construction4/				872
Road Construction4/				1,972
Facilities Construction4/				6,982
Well Modification	0	916	259	1,175
Pump Modification	844	0	0	844
Implementation	259	517	517	1,293
Total Change5/	**1,103**	**1,433**	**8,428**	**20,790**
Change as % of 1995 Employment	1.47	1.55	5.58	6.52

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years. A number of the impacts have a wide range of variation depending on the magnitude of construction and the length of the time period.

2/ The three subregions comprise the lower Snake River study area. Employment change in this area includes the sum of employment change across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.

3/ The DREW Hydropower Impact Team (DREW Hydropower Impact Team) assumed that a total of six replacement power plants would be built. The exact locations of these plants are unknown but DREW Hydropower Impact Team assumed that three would be located in the downriver subregion, with the other three most likely located in the Puget Sound region. Construction of each power plant is estimated to generate 2,786 short-term jobs. The estimates shown in this table are the maximum number of these jobs that would be generated in any one year—5,572 in the downriver subregion, where two plants would be constructed simultaneously.

4/ These effects would occur in the lower Snake River study area but it is not known how they would be distributed among the subregions.

5/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River Study Area figure because some of the projected Study Area impacts were not distributed by subregion.

Table 10-5. Long-Term Employment Effects (Jobs) [1/]

	Upriver	Reservoir	Downriver	Total Lower Snake River Study Area[2/]
1995 Employment	75,081	92,535	151,124	318,740
O&M Spending on Replacement Power Plants & New Transmission Lines	0	0	884	884
Recreation (inc. Angling) [3/]				1,393
Total Long-Term Employment Gain[4/]	**0**	**0**	**884**	**2,277~**
Reduction in Irrigated Lands	0	(1,105)	(474)	(1,579)
Avoided Costs (Reductions in Corps' Spending)	(133)	(1,060)	(133)	(1,326)
Reduced Cruise Ship Operations	(83)	0	0	(83)
Total Long-Term Employment Loss	**(216)**	**(2,165)**	**(607)**	**(2,988)**
Net Long-Term Employment Change[4/]	(216)	(2,165)	277	(711)
Net Change as a % of 1995 Employment	(0.29)	(2.34)	0.18	(0.22)

1/ Midpoints are shown when only lower and upper bounds were available from other DREW workgroups. Averages are shown when the effects vary by year over a number of years.
2/ The three subregions comprise the lower Snake River study area. Employment change in this area is the sum of employment change across the three subregions. Some of the projected Study Area impacts were not distributed by subregion.
3/ These effects would occur in the lower Snake River study area, but it is not known how they would be distributed among the subregions.
4/ The upriver, reservoir, and downriver subtotals do not sum to the total lower Snake River Study Area figure because some of the Study Area impacts were not distributed by subregion.

Impacts would also occur throughout the Pacific Northwest, throughout a state, or in an area of a State outside a subregion. These impacts include reductions in business sales, employment, and personal income associated with increased electricity bills. Positive impacts would be associated with replacement power plant construction and operations in the Puget Sound region, construction of tidewater rail care storage in Oregon, and increases in commercial and ocean recreation harvest of anadromous fish in the Pacific Northwest states, Alaska, and British Columbia, Canada.

10.6 Social Impacts

The majority of communities in the lower Snake River region are small rural towns that have low to moderate economic diversity. These communities primarily rely on the agricultural and wood products sectors, even though they have declined as a source of regional employment and income over the past decade.

10.6.1 Alternatives 2 and 3

Alternatives 2 and 3 are estimated to have little effect on the existing social and economic environment for the majority of the communities within the region. Some communities, particularly those located up river, (e.g., Lewiston, Orofino, and Riggins), could be adversely affected by lower probabilities of salmon recovery. Continued Federal oversight and uncertainty about the future of the four dams may also have negative social effects on some communities.

10.6.2 Alternative 4

Breaching the four dams would change the physical and economic environment of the lower Snake River region. Communities located upriver of the four dams (e.g., Lewiston, Orofino, and Riggins) would likely experience net employment gains as a result of expected increases in recreation and tourism associated with a free-flowing river and to a lesser extent increased fish runs. Communities located within the six counties located adjacent to the lower Snake River reservoirs (e.g., Pomeroy, Colfax, and Clarkston) would likely experience a net decrease in employment due to decreases in Corps employment and increased pressure on family farms caused by increased transportation, storage, and handling costs for agricultural products.

Communities located downriver of Ice Harbor dam (e.g., Pasco, Kennewick, and Umatilla) would likely experience employment loss if farms presently irrigated from Ice Harbor reservoir go out of business. These losses may be partially offset by expected increases in transportation- and power generation-related employment.

Communities would likely adjust to these changes over time. New individuals and businesses seeking new opportunities may replace those that have been displaced. Displaced human and capital resources may be employed in their next best use within the community. This type of adjustment does, however, take time and would vary by community. Community size has been identified as a critical factor affecting a community's ability to adapt to change, with smaller, less diverse communities tending to respond less favorably.

Many of the community level impacts could be caused by the loss of irrigated agriculture on Ice Harbor reservoir and increased grain transportation costs. These impacts may be minimized or partially eliminated by mitigation spending to modify existing irrigation pumps and spending to expand rail capacity in the region or by directly subsidizing affected farms.

11. Cost Allocation

The purpose of the Cost Allocation analysis is to examine a range of possible cost allocation approaches that could be used to distribute costs of the proposed alternatives. The primary purpose of allocating project costs is to identify repayment responsibility with respect to cost recovery, cost sharing, or both (as may be required). The following discussion does not recommend a preferred approach at this time. However the cost implications of the approaches are shown using the preliminary construction costs and the unrecovered Federal investment.

11.1 Purpose

From a Federal perspective, cost allocations are made to derive an equitable distribution of project costs among authorized project uses, or those proposed for authorization. Laws and regulations requiring reimbursement or cost-sharing generally specify recovery of costs incurred for the service or function. Cost allocation is, therefore, required for most Federal multipurpose projects having reimbursable purposes.

The cost allocation is an essential part of the multipurpose planning process where cost-sharing will be required. It provides information needed to determine the magnitude and share of estimated project costs that are reimbursable. This information is essential to the tests of financial feasibility and plan acceptability. During subsequent planning and construction, it provides the information required for allocating actual expenditures and insures that cost accounts are maintained consistent with the plan formulation and allocation principles.

The authorizing document for the lower Snake River projects, PL 79-14, designated the Federal Power Commission (now the Federal Energy Regulatory Commission [FERC]) as the agency responsible for defining the allocation of costs to navigation and hydropower. The Final Cost Allocations were completed by FERC in 1965 for Ice Harbor, and 1984 for Lower Monumental, Little Goose, and Lower Granite. FERC completed the allocation studies based on data and preliminary allocations done by the Corps of Engineers. Any new cost allocations for these projects will be coordinated with FERC.

It has been Corps policy not to request reallocation of storage and/or project costs unless a major reformulation of a project is required. Some of the actions that may be recommended in this Feasibility Report could require authorization by Congress. The Congressional authorization could contain directive language concerning the allocation of costs. In the absence of such directive language, the Corps of Engineers' administratively developed procedures would be utilized to allocate the project costs.

11.2 Allocating Costs

11.2.1 Assumptions

The Dam Breaching alternative could affect the existing cost allocations because of the possible deletion of authorized uses (navigation and hydropower). Implementation could likely result in new cost allocations being considered for all the facilities being proposed for breaching (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor). A change in the existing allocations would not only affect how implementation costs are allocated, but also the existing debt on the projects.

Because the economic benefits at these multi-use facilities could be significantly altered between purposes, they can be considered for new cost allocations. Table 11-1 identifies which alternatives are likely to require new cost allocations.

Table 11-1. Alternatives Requiring New Cost Allocations

Alternatives	New Cost Allocations Necessary
1 Existing Condition – Base Case	No
2 Maximum Transportation	No
3 Major System Improvements	No
4 Dam Breaching	Yes

Approaches to cost allocation could be quite different depending on the alternative recommended. As long as the measures do not significantly effect the current authorized uses, the costs would be allocated to mitigation according to the existing joint-use percentages. Historically, costs for fish transportation and bypass measures have been defined as mitigation. It is assumed similar alternatives like transportation and fish bypass improvements would also be assigned to mitigation and shared according to the original joint-use percentages. Therefore, it is expected that new cost allocations would only be necessary for the drawdown or dam breaching alternative. Table 11-2 shows the construction joint-use percentages for the lower Snake River projects as established by the initial allocations.

Table 11-2. Joint-Use Percentages for Construction Costs by Authorized Project Uses

Facility	% Allocated to Power	% Allocated to Navigation
Lower Monumental	94.1	5.9
Ice Harbor	78.6	21.4
Little Goose	93.3	6.7
Lower Granite	98.4	1.6

11.2.2 Methodology

Alternatives being considered for this Feasibility Report could be described as either mitigation or restoration of endangered salmon runs.

How the alternatives are characterized could change the way the costs are allocated. Mitigation measures are joint-use costs allocated based on the original firm cost allocations. Joint-use costs are assigned to those facilities that serve more than one authorized use. Currently, barging of juvenile fish and bypass measures at the projects are considered mitigation actions. Restoration measures by comparison would be allocated solely to ecosystem restoration.

The unrecovered Federal debt is comprised of investment costs allocated to power for the four lower Snake facilities (Lower Granite, Little Goose, Lower Monumental, and Ice Harbor). Total remaining debt as of the end of 1998 was approximately $479 million for construction of the dams and $271 for the lower Snake River fish hatcheries and fish mitigation. The BPA re-pays this debt to the Federal government from power revenues. The four lower Snake River facilities began producing power between 1962 and 1975.

For illustrative purposes, the unrecovered Federal debt is considered part of the implementation costs and is allocated according to the requirements for mitigation or restoration for the drawdown or dam breaching alternative. At this point however, it is not clear what obligation, if any, BPA would have to repay this outstanding debt in the event the dams are breached. BPA's obligation would likely be determined based on legal opinion, congressional direction, and negotiation.

11.3 Potential Approaches To Allocating Costs For Dam Breaching

It should be recognized that when Congress provides the authorizing legislation for any of the alternatives being investigated in this Feasibility Report, it can designate what cost allocation or cost sharing approach to be used. As such, the possible alternative approaches to allocating costs are infinite. This section, however, presents two possible approaches for allocating drawdown costs that follow the current administrative guidelines.

11.3.1 Cost Share as Mitigation

Under this option the cost of the drawdown alternative would be treated as a mitigation cost. The concept behind this option is that the construction and operation of these projects for the hydropower and navigation has resulted in declining wild salmon and steelhead stocks that represent an unmitigated loss that has accrued to the facilities. If the drawdown alternative is recommended for implementation as a mitigation project, it would be on the basis that it is the most effective mitigation or only effective mitigation for this loss. Therefore, the cost of achieving this mitigation would be properly assigned back to the authorized uses that necessitated the mitigation. This has been the approach for recent fish and wildlife measures at Columbia and Snake River dams. An issue is whether costs should be allocated to authorized uses that have been eliminated.

The costs could be allocated based on existing joint use percentages. Nearly 90 percent of the cost would be allocated to hydropower and repaid to the U.S. Treasury by BPA through collections from power customers. Navigation would be allocated 10 percent of the cost and these costs would be Federal and not recoverable. The remaining unrecovered hydropower debt on the lower Snake River dams would continue to be paid to the U.S. Treasury through collections from power customers. Any operation and maintenance costs associated with the drawdown alternative (for example maintenance of the locks and remaining dam in caretaker status) could be allocated to the hydropower and navigation and shared as the operation and maintenance costs.

If one assumes that breaching of the dams is an additional or new feature for mitigation purposes, costs should be allocated as joint-use construction costs. The joint-use cost percentages would be the basis for this allocation. Tables 11-3 and 11-4 estimate how the unrecovered debt and implementation and O&M costs would be allocated for Alternative 4, Dam Breaching.

Table 11-3. Mitigation – Allocated Investment Costs and Unrecovered Debt

Alternative 4 Preliminary Costs – Allocated by Authorized Uses (1998 dollars) ($1,000)		
	Investment Cost	Unrecovered Debt
Hydropower	875,334	750,000
Navigation	86,572	0
Non-reimbursable Costs	6,826	0
TOTAL	**968,732**	**750,000**

Source: Section 3.8 Implementation and Avoided Costs

Table11-4. Mitigation – Allocated O&M Costs

Alternative 4 Preliminary O&M Costs – Allocated by Authorized Uses (1998 dollars) ($1,000)	
	Operation & Maintenance Cost
Hydropower	4,375
Navigation	481
TOTAL	**$4,856**

Source: Section 3.8 Implementation and Avoided Costs

11.3.2 Cost Share As Restoration

Under this option, the cost of Alternative 4, Dam Breaching, would be shared as an ecosystem restoration cost and would require a non-Federal cost sharing sponsor. Remaining unrecovered hydropower debt on the lower Snake River dams would also be included as a restoration cost. Any operation and maintenance costs associated with the drawdown alternative (for example maintenance of the locks and remaining dam in caretaker status) would be financed 100 percent by a non-Federal sponsor. Section 210 of the Water Resources Development Act of 1996 established the non-Federal cost share for environmental protection and restoration as 35 percent non-Federal with operation and maintenance of the ecosystem restoration project being 100 percent non-Federal.

However, there may be precedent for 50 percent non-Federal cost sharing for ecosystem restoration activities which result in adverse impacts to purposes of an existing Federal project as in the case of the Kissimmee River Restoration and Everglades and South Florida Ecosystem. The operation and maintenance costs of the restoration remain non-Federal.

If one assumes that breaching of the dams is a restoration measure, costs could be allocated solely to this purpose. Because drawdown results in a single project purpose (ecosystem restoration), all costs should be allocated to this new project purpose. Tables 11-5 and 11-6 estimate how the unrecovered debt and implementation and O&M costs would be allocated for Alternative 4, Dam Breaching, assuming restoration is the sole purpose.

Table 11-5. Restoration – Allocated Investment Costs and Unrecovered Debt

Alternative 4 Preliminary Costs – Allocated to Ecosystem Restoration (1998 dollars) ($1,000)		
	Investment Cost	**Unrecovered Debt**
Ecosystem Restoration	968,732	750,000
TOTAL	968,732	750,000

Source: Section 3.8 Implementation and Avoided Costs

Table 11-6. Restoration – Allocated O&M Costs

Alternative 4 Preliminary O&M Costs – Allocated to Ecosystem Restoration (1998 Dollars) ($1,000)	
	Operation & Maintenance Cost
Ecosystem Restoration	$4,856
TOTAL	$4,856

Source: Section 3.8 Implementation and Avoided Costs

11.3.3 Financial Analysis

If all costs were allocated to ecosystem restoration, there would also be an issue of cost sharing. A non-Federal sponsor would need to be identified for cost sharing. A non-Federal sponsor is a legally constituted body with full authority and capability to perform the terms of its agreements and to pay damages, if necessary, in the event of failure to perform. The non-Federal share of the implementation costs and unrecovered debt would be 35 percent. The non-Federal sponsor would also be responsible for 100 percent of operation, maintenance, and replacement costs for a restoration project. Tables 11-7 and 11-8 display the cost sharing portions for the Federal and non-Federal sponsor if the action is determined to be restoration.

A more detailed discussion of potential funding options is presented in the following section, Section 12.0 Financial Analysis.

Table 11-7. Restoration – Unrecovered Debt and Investment Cost - Cost Sharing for the Federal and Non-Federal Sponsor

Alternative 4 Preliminary Costs – Allocated to Ecosystem Restoration (1998 Dollars) ($1,000)		
Sponsor	Investment Cost	Unrecovered Debt
Federal (65%)	629,676	487,500
Non-Federal (35%)	339,056	262,500
TOTAL	968,732	750,000

Source: Section 3.8 Implementation and Avoided Costs

Table 11-8. Restoration – O&M Costs – Cost Sharing for the Federal and Non-Federal Sponsor

Alternative 4 Preliminary O&M Costs – Allocated to Ecosystem Restoration (1998 Dollars) ($1,000)	
Sponsor	Operation & Maintenance Cost
Non-Fedcral (100%)	$4,856
TOTAL	$4,856

Source: Section 3.8 Implementation and Avoided Costs

12. Financial Analysis

12.1 Introduction

The purpose of this analysis is to describe the potential funding options for the projects being evaluated in the Lower Snake River Juvenile Salmon Migration Feasibility Study. This analysis is designed to provide information for policy makers regarding the availability of funding for the proposed alternatives within established *Principles and Guidelines for Water and Related Land Resources Implementation Studies* (WRC, 1983). The following discussion is divided into 3 sections that address the following issues: funding requirements, potential sources of funding, and financial impacts.

12.2 Funding Requirements

The potential funding request could include three items:

- Repayment of outstanding debt
- Implementation costs to construct fish-related improvements
- Mitigation and compensation costs

12.2.1 Repayment of Outstanding Debt

The Bonneville Power Administration (BPA) is obligated to repay to the Federal Treasury all costs allocated to hydropower from the Federal dams. The capitalized costs of the project (e.g., initial construction costs, replacement costs, etc.) are repaid by BPA over a 50 year period at designated interest rates. The current debt associated with the lower Snake River lock and dams is estimated as follows:

- Amounts already included in existing rate structure:
  - Approximately $479 million for construction of the dams (e.g., as of the end of 1998)
  - Additional outstanding debt for the lower Snake River fish hatcheries and fish mitigation funds of approximately $271 million as of the end of 1998
- Amounts that will be included in the rate structure, upon completion:
  - Construction work in progress account will transfer to BPA as new additional debt (e.g., approximately one-half of the $271 million in construction work in progress is occurring in the lower Snake River facilities)

As indicated, these costs are (or could be) built into the existing BPA power rates. If the lower Snake River lock and dams are breached, it is possible that Congress, through authorizing legislation, will reduce some or all of this long-term debt or BPA ratepayers may be required to continue repayment.

12.2.2 Implementation Costs

Table 12-1 presents a summary of the costs associated with fish-related facility improvements. These implementation costs could also require payment or, alternatively, could be covered by congressional appropriation.

Table 12-1. Construction & Acquisition Costs by Study Alternative (1998 dollars) ($1,000s)

Alternative	Detailed Description	Starting Year	Construction & Acquisition Costs ($)
1—Existing Conditions	Adaptive Management Strategy	2005	97,990
2—Maximum Transport of Juvenile Salmon	Maximum Transport	2005	74,693
3—Major System Improvements	SBC with Maximum Transport (low cost)	2006	167,972
4—Dam Breaching	Channel Bypass or Natural River Alternative	2007	809,530

1/ These costs have been adjusted to base year 2005 using the 6.875 percent discount rate.
SBC—Surface Bypass Collectors
Source: U.S. Army Corps of Engineers, Walla Walla District

The capital cost to retain the dams ranges from $74.7 million to undertake Alternative 2, Maximum Transport, to $168.0 million to undertake Alternative 3, Major System Improvements. Alternative 4, Dam Breaching, is expected to cost approximately $809.5 million for deconstruction of the dams, construction of a channeled river, and related capital costs.

12.2.3 PossibleMitigation and Compensation Costs

Alternative 4, Dam Breaching, would also engender other costs to replace services currently provided under existing conditions, including:

- Additional annual power costs of $241.8 million per year to develop alternative sources of power (e.g., includes the cost of constructing and operating combined cycle gas turbines less the cost of operating the existing system)
- Additional transportation costs of $24.0 million per year to move commodities by rail and/or to truck to more distant barge terminals in the John Day pool
- Additional costs to supply water to irrigators and municipal/industrial users of $15.4 million per year
- Additional (but non-quantified) costs to retrain workers, and mitigate or compensate public and private entities for such losses as idle barges and terminals, additional road damage, and other impacts

There is no requirement for the Federal government to provide compensation for these costs but a legislative solution may be developed to provide mitigation and/or compensation.

12.3 Potential Sources of Funding

Under the dam retention strategies, implementation costs would be covered by the existing cost allocation rules. However, if dam breaching were the selected alternative, there are three potential sources for funding:

- Continue with the existing cost allocation rules (under Corps fish mitigation principles)
- Seek a local sponsor who would share the costs with the Federal government for dam breaching, (under Corps fish recovery principles)
- Congress authorizes the Treasury to pay all (or a part) of the cost to breach

These issues are addressed in the following section.

12.3.1 Existing Cost Allocation Basis (Fish Mitigation)

As documented in the cost allocation analysis (Section 11.0), the repayment cost of existing projects is mainly allocated to power. Under existing cost allocation rules, power is currently required to pay for approximately 91 percent of the costs associated with the projects (e.g., averaged across all four lower Snake River facilities). BPA repays the Treasury for these costs. Navigation is responsible for the remaining 9 percent of costs, which is considered a Federal cost. Table 12-2 shows the joint-use percentages for construction costs by project uses.

Table 12-2. Joint-Use Percentages for Construction Costs by Project Purposes

Projects	% Allocated to Power	% Allocated to Navigation
Lower Monumental	94.1	5.9
Ice Harbor	78.6	21.4
Little Goose	93.3	6.7
Lower Granite	98.4	1.6
Simple average across all four facilities	91.1	8.9

Source: Cost Allocation Report

Existing cost allocation rules would require that approximately 91 percent of the implementation costs are covered in BPA rates, with the remaining 9 percent covered by the Federal government.

12.3.2 Cost Sharing with a Local Sponsor (Fish Recovery)

The typical process of developing a finance plan for a Corps construction program is to develop a cost sharing agreement between a local sponsor and the Federal government.

In accordance with the Water Resources Development Act of 1986 (PL 99-662), costs for studies and projects are shared between the Federal Government and the local sponsor. A sponsor is defined as:

> *A sponsor can be a state or any other political subpart of a stem or group of states; an Indian tribe; or a port authority; which has the legal and financial authority and capability to provide the cash and real estate requirements needed for a*

project. A sponsor can also be an interstate agency, established under two or more states with the consent of Congress under Section 15 of Article 1 of the Constitution Section 221 of the 1970 Flood Control Act defines a local sponsor for a Corps water resources project as a non-Federal interest that is "a legally constituted public body with full authority and capability to perform the terms of its agreements and to pay damages if necessary, in the event of failure to perform.

In this study, there is no local sponsor. This feasibility report is furnished in response to the NMFS Biological Opinion for the *Reinitiation of Consultation on 1994-1998 Operation of the Federal Columbia River Power System and Juvenile Transportation Program in 1995 and Future Years.* Therefore, the source of funds to implement a drawdown is uncertain.

12.3.3 Congressional Appropriation

Implementation of the dam breaching alternative could be funded entirely (or partially) by direct congressional appropriation. As described in the Technical Report on Hydropower Costs and Benefits (DREW HIT, 1999; Section 7.1., Page 104):

> *Congress will ultimately answer the repayment question in the legislation that would authorize the implementation of the selected alternative. The Congressional authorization could contain directive language concerning the allocation of project construction costs. For example, Congress could direct that removal of the Snake River Dams is of national interest and the taxpayers' responsibility, and BPA would not have to repay any of the construction costs.*

It is unknown at the present time whether congressional authorization would be forthcoming for all or part of the outstanding debt, implementation costs and/or mitigation/compensation costs.

12.4 Financial Impacts

The following section addresses BPA's authorization and ability to pay for the dam breaching costs as well as the potential impact of rate increases on BPA ratepayers.

12.4.1 BPA Funding

BPA is authorized to pay for fish and wildlife mitigation projects under the following legislation:

> Under provisions of the Northwest Power Planning and Conservation Act [PL 96-501, Section 4(h)(2)(A)], BPA is required *"to use its funding authorities to protect, mitigate, and enhance fish and wildlife to the extent such resources are affected by the hydroelectric projects of the Columbia River and its tributaries".*
>
> In addition, *...BPA expenditures shall be in addition to, not in lieu of, other expenditures authorized to be made by other entities under other agreements or provisions of the law. Other fisheries efforts outside this Act, for example, are expected to continue and to be funded separately.*
>
> Under provisions of the Northwest Power Planning and Conservation Act (PL 96-501), *the Bonneville Power Administration is self-financed. Pursuant to the Federal Columbia River Transmission Act, BPA must meet all its costs, including*

the cost of the Federal investment in the Columbia River system, from its power sale revenues. General tax revenues are not used to support BPA programs.

However, there are limitations on how much of the additional fish and wildlife mitigation costs BPA can accommodate. Five Federal agencies involved in salmon and other fish and wildlife restoration activities in the Columbia River Basin established a Memorandum of Agreement (MOA) concerning BPA fish and wildlife costs for Fiscal Years 1996 through 2001. The MOA followed an agreement made between NMFS, members of the Pacific Northwest congressional delegation, and the Clinton Administration, to establish an upper limit on BPA costs for Columbia Basin fish and wildlife, at an average of $435 million per year through the 6-year period. This MOA was undertaken due to concern over BPA's financial position and its ability to fund future fish and wildlife programs in a deregulated power market.

The Technical Report on Hydropower Costs and Benefits further describes the limits of BPA's abilities to raise rates in the presence of increasing costs:

> *In a restructured, competitive, wholesale power market, BPA can no longer automatically recover higher costs by raising its rates. This is because the utilities that buy power from BPA have alternative supplies of electricity available at prices set by the wholesale electricity market. If BPA's prices are below the market price, it may be able to recover increased costs until its prices reach the market price. However, consumers of BPA power are no longer required to bear the financial impacts of increased hydroelectric costs if less expensive electricity is available in the market. In this case, the financial impacts will be more difficult to determine. Initially, the cost would appear as BPA losses, but those losses would have to be covered by someone such as taxpayers or users of the still-regulated transmission system.* (DREW HIT, 1999; Section 7.1, page 104)

The Northwest Power Planning Council recently evaluated BPA's potential financial conditions under a wide range of future electricity market conditions and possible fish and wildlife mitigation scenarios, including all of the alternatives being considered in this study. The analysis concluded:

> *Under a wide range of conditions, Bonneville demonstrates significant value to customers even if called upon to bear relatively large additional fish and wildlife mitigation costs. Only under combinations of persistent low market conditions and increased fish and wildlife costs and/or operational impacts does Bonneville experience significant negative net revenues for extended periods. Those results are extremely sensitive to small changes in Bonneville's costs or market prices. This underscores the importance of Bonneville's cost management efforts. Financial risk management mechanisms like reserves can mitigate the negative net revenues in some conditions. In other conditions, however, the mitigating effect of the assumed reserves and/or further cost reductions is insufficient. In these cases, Bonneville would need larger reserves; some sort of contingent cost recovery mechanism or may have to look to other [sources] of funding. It is also possible that the schedules for implementation of the various fish and wildlife mitigation scenarios used in this analysis will not be met. The biological and economic effects of changes in the schedule for implementation of fish and wildlife measures should*

be evaluated. (Source: Analysis of the Bonneville Power Administration's Potential Future Costs and Revenues, June 5, 1998, Executive Summary, Page 9)

12.4.2 Potential Impact on Rate Payers

The Technical Report on Hydropower Costs and Benefits prepared an estimate of the impact of dam breaching on BPA ratepayers. It should be emphasized that these estimates are intended for illustrative purposes only and are based on several qualifying assumptions. The estimates of potential rate increases from the additional costs allocated to hydropower (e.g., this excludes the portion of implementation costs allocated to navigation as well as any mitigation/compensation costs) are summarized below:

- "the average PNW household monthly electricity bill could increase between $1.20 and $6.50 depending on which set of cost distribution and economic forecast assumptions is applied,
- the monthly bill impact for the average PNW commercial establishment could increase between $6.70 and $36.30, and,
- the major impact would be to the industrial sector if the assumed cost distributions occur. For example, the average industrial customer (excluding the aluminum companies and other Direct Service Industries) could see monthly electricity bills increase between $302 and $1,645. The aluminum companies in the PNW are extremely large consumers of electricity, and this is reflected in the average monthly consumption of 160,600,000 kWh. Clearly, any increase in the electricity rate will have a significant impact on the monthly power bills. Depending on the selection of cost distribution and economic condition impacts, the average monthly power bill for aluminum companies could increase between $172,600 and $940,400." (Source: DREW HIT, 1999; Section 7.4, pages 107-113).

13. Compensatory Actions

13.1 Introduction & Study Organization

The purpose of this analysis is to describe and document the potential mitigation and/or compensatory actions that could be undertaken to alleviate the impacts associated with the study alternatives under consideration. There are two types of potential mitigation and/or compensation actions that are addressed in the following discussion:

1. Federal mitigation actions, which are included in implementation costs:
   - Fish & wildlife programs,
   - Cultural resources, and,
   - Tribal responsibilities.
2. Potential mitigation or compensation actions:
   - Mitigation activities which may be economically viable and socially desirable - if the combined cost of the mitigation plan and resulting reduced impacts are less than the initial impacts, the plan meets the requirements of being "reasonable and prudent" in an economic sense.
   - Compensation activities, which may be socially desirable, include areas where losers may be "made whole" by compensating them for losses.

The Corps process for determining NED impacts accounts for the most efficient (or least cost) way of accommodating changes in water budget use from the national perspective. In most cases, the national estimate of impacts documents the potential net increase in costs (or benefits) but does not provide a means to compensate or mitigate for the losses.

In addition, there may be significant regional costs that are not taken into account in the national impact estimates.

The decision to fund mitigation and compensation plans is ultimately a congressional decision. The goal of this report is to identify a menu of mitigation and compensation efforts for decisionmakers by documenting quantifiable NED impacts and qualitative regional impacts that may be considered to mitigate and/or compensate losses.

The following section provides a description of Federal mitigation costs and other potential mitigation/compensation costs.

The primary purpose of the economic appendix is to evaluate the costs associated with the four alternatives. Earlier PATH biological output (e.g., 1998 model results) suggested that the Alternative 4, Dam Breaching, was the only alternative that satisfied most of the NMFS jeopardy standards, especially for the 48-year recovery standard for fall chinook. However, newer PATH model results indicate that the dam retention alternatives also meet the NMFS jeopardy standards. As a result, the mitigation and compensation actions suggested below may not be needed. They are,

however, documented in this chapter to illustrate what actions may be considered, if dam breaching were the selected alternative.

13.2 Description of Federal Mitigation Costs

Federal mitigation efforts include fish and wildlife mitigation and cultural resources protection efforts, which may require mitigation of impacts caused by Alternative 4, Dam Breaching. Dam retention alternatives (Alternatives 1, 2, and 3) do not require new mitigation. However, previous mitigation projects, put in place when the dams were constructed, would remain under all alternatives.

13.2.1 Fish & Wildlife Mitigation

Fish and wildlife mitigation is estimated to cost $20.7 million per year over the 100-year study life for Alternative 4, Dam Breaching. This estimate is presented in year 2005 dollars and is based upon discounting at the 6 7/8 percent discount rate (see Table 13-1). Mitigation for fish and wildlife impacts related to the dam breaching alternative would include:

- Structure modifications — such as maintaining road access to existing habitat management units (HMUs), and modifications to fish hatcheries, among other items;
- Vegetation restoration — such as seeding the exposed banks of the river with grass, propagation of plants and willows, and noxious weed control, among other items;
- Maintenance of existing habitat management units — primarily developing alternative water sources or modifying systems for existing HMUs; and
- Monitoring of ongoing work to see how fish and wildlife species and vegetation are developing — efforts include conducting a seasonal bird census, nesting surveys, and habitat evaluation monitoring, among other items.

13.2.2 Cultural Resources Protection

Cultural resources preservation entails preserving and protecting cultural sites (e.g., burial grounds and other culturally significant sites) after the dams are breached. The cost to protect cultural resources includes protecting sites (e.g., preparing seed beds, undertaking bank stabilization as needed on a site-by-site basis). Cultural resources protection is expected to cost $4.9 million per year over the 100-year study period. This estimate is presented in year 2005 dollars and is based upon discounting at the 6 7/8 percent discount rate (see Table 13-1).

Table 13-1. Federal Mitigation Costs for Alternative 4, Dam Breaching (2005 dollars) ($1,000)

Component	Cost ($)
Fish & Wildlife Mitigation Costs	20,772
Cultural Resources Mitigation Costs	4,924
Total	25,696

Note: Average annual amounts based upon 6 7/8 percent discount rate.
Source: U.S. Army Corps of Engineers, Walla Walla District

13.3 Description of Other Potential Mitigation/Compensation Costs

These mitigation activities are defined to include:

- Mitigation activities, which may be economically viable and socially desirable (e.g., areas where impacts could be diminished or mitigated), and,
- Compensation activities, which may be socially desirable (e.g., areas where losers may be compensated for losses or "made whole" by compensating them for losses).

The following section describes both the potential quantifiable and qualitative impacts, for which mitigation and/or compensation efforts could be considered.

13.3.1 Implementation Costs

The cost of implementing the study alternatives ranges dramatically across alternative. Under the dam retention alternatives, implementation costs are expected to increase modestly (e.g., costs increase by approximately $5.9 million per year under Alternative 3, Major System Improvements — as compared with Alternative 1, Existing Conditions). However, under the dam-breaching alternative, implementation costs are expected to increase by nearly $8 to $49 million per year, depending on the discount rate (Table 13-2), if non-Federal mitigation is included.

Table 13-2. Summary of NED Costs (1998 dollars) ($1,000)

Discount Rate	Implementation Costs ($)	Power* Costs ($)	Navigation Costs ($)	Irrigation/Water Systems Costs ($)	Total Costs ($)
@6.875%					
Alternative 2	(3,457)	(8,500)	---	---	(11,957)
Alternative 3	5,931	(8,500)	---	---	(2,569)
Alternative 4	48,787	271,000	24,034	15,424	359,245
@4.75%					
Alternative 2	(2,556)	(8,500)	---	---	(11,056)
Alternative 3	4,376	(8,500)	---	---	(4,124)
Alternative 4	35,498	267,500	25,249	10,746	338,993
@0.0%					
Alternative 2	(663)	(8,000)	---	---	(8,663)
Alternative 3	1,390	(8,000)	---	---	(6,610)
Alternative 4	8,298	263,500	28,330	2,241	302,368

* Equals increased alternative power costs less avoided costs (e.g., turbine rehabilitation costs for the dam retention alternatives).
Source: U.S. Army Corps of Engineers, Walla Walla District and various FR/EIS study teams

There is currently no method to pay these implementation costs, which could be integrated into a mitigation/compensation strategy.

13.3.2 Power Mitigation/Compensation Actions

The overall cost of producing power (e.g., including system transmission reliability and ancillary services costs) is expected to decrease slightly under dam retention alternatives (Alternatives 2 and 3) as compared with the existing conditions (Alternative 1). Under Alternative 4, Dam Breaching, the cost of alternative power is expected to increase by approximately $263 to $271 million per year over the 100-year study period, depending on the discount rate.

The economic impacts of power rate increases are expected to be widely distributed in varying degrees amongst the electric ratepayers throughout the WSCC region (e.g., WSCC comprises all or part of the 14 western states and British Columbia, Canada). The Pacific Northwest region is, however, likely to be the most impacted sub-region based on the regional system production costs. It is expected that the power rate impacts to each individual electric ratepayer could fall within a wide range of possibilities.

No possible mitigation measures were identified in the hydropower analysis. To mitigate for the increased power system costs some alternative way of meeting power demands (loads) would need to be identified. The hydropower analysis, however, identified the most cost-effective way to meet power loads with each of the alternatives. Any possible mitigation plan would be more costly and hence would not mitigate the impacts, but only change them to some other mix of power resources.

Subsidizing each ratepayer an amount equivalent to the impact could compensate the economic effects of potential power rate increases. This could come from the nation's taxpayers to the regional ratepayers, which would require congressional authorization. This compensation would constitute a transfer of the economic effects from one region of the country to the entire country.

13.3.3 Navigation Mitigation/Compensation Actions

The loss of barge transportation under the dam breaching alternative would likely lead to an increased use of alternative (and more costly) cargo transportation systems. This would entail longer truck travel to more distant barge terminals or a shift to rail transportation services. The net NED costs incurred by cargo shippers are expected to be approximately $24 to $28 million per year for the 100-year study period, as shown in Table 13-2, depending on the discount rate.

According to the Transportation team, shifting from the existing transportation system to the next less costly system would increase overall grain transport costs by approximately 19 percent per bushel.

The magnitude of the NED costs does not, however, take into account a potential rate adjustment by railroad carriers in response to the loss of competition by the barge lines. There is a general concern among shippers that the railroads may raise their rates affecting the cargo currently moving by barge as well as some cargo that is currently carried by rail. If rail rates were raised, the additional cost to farmers would be a wealth transfer from farmers/exporters to the railroads but would not be considered a NED cost.

In addition to these additional NED costs, there are also additional expenditures that would be required to improve the transportation infrastructure. As shown in Table 13-3, the cost to upgrade railroads, highways and storage facilities could range from $210 to $535 million. The transportation analysis assumes that the existing rate structures would generate sufficient funds to pay for these improvements.

Table 13-3. Summary of Estimated Costs of Infrastructure Improvements (in millions of 1998 dollars)

Infrastructure Improvements	Low ($)	High ($)
Mainline Railroad Upgrades	14.0	24.0
Short-Line Railroad Upgrades	19.9	23.8
Additional Rail Cars	14.0	26.9
Highway Improvements	84.1	100.7
River Elevator Capacity	58.7	335.4
County Elevator Improvements	14.0	16.9
Rail Car Storage	5.3	7.4
Total	210.0	535.0

Source: Transportation Chapter, Table 3.3-19

In addition, other components of the barge industry transportation system could experience losses in income from:

- Commercial barge companies — foregone revenue and idle capacity,
- Selected grain elevators — loss of revenue, idle capacity,
- Selected port districts — loss of revenue, idle capacity,
- State and local governments — additional road and highway maintenance costs and possible loss of tax revenues.

There is no current means to mitigate or compensate for these potential NED costs, wealth transfers and qualitative losses.

13.3.4 Irrigation and Municipal/Industrial Water Supply Mitigation/ Compensation Actions

The NED costs for irrigation and water systems have been estimated at $15.4 million per year at a discount rate of 6 7/8 percent. This measure of impact assumes that:

- The value of the farmland would be reduced due to the loss of irrigation,
- Municipal and industrial pump stations will need to be improved, and
- Privately owned wells will need to be replaced.

There is no current means to mitigate or compensate for these potential NED costs. If congressionally authorized and funded, potential mitigation/compensation efforts could include:

- Payment for required improvements, and
- Potential purchase of farm land.

13.3.5 Social Mitigation/Compensation Actions

The long-term employment losses across the Pacific Northwest could be approximately 5,338 to 6,008 jobs as a result of implementation of Alternative 4, Dam Breaching, according to the Social Analysis Report. The total jobs gained under Alternative 4 are forecast at between 3,796 and 4,722 after 20 years. Approximately 4,000 of the job losses represent identifiable dislocated or displaced workers. Overall adverse community-level social impacts include the following:

- Decrease in net farm income and increased financial pressure on dryland farmers throughout the region,
- Increasing consolidation of family farms and a decrease in rural farm population,
- Decrease in county property tax base in 20 regional counties,
- Dislocated workers from Ice Harbor Irrigated agricultural lands and loss of source of local school revenue, and
- Shift in the economic base of communities and changed potential for future growth.

Many of these significant community-level and employment impacts are caused by the increased costs of grain transportation and by the loss of irrigated agriculture on the Ice Harbor Reservoir, which would occur under the dam breaching alternative. These impacts could be minimized in part by modification of the irrigation pumps and direct upgrades to expand rail capacity in the region and/or a direct subsidy to the farms currently shipping on the lower Snake River, as discussed in the previous section.

In the absence of direct mitigation to impacted parties for increased transportation costs, loss of irrigation water, and other impacts discussed above, employment losses could be addressed by providing targeted job retraining and education credits, at an estimated cost of between $45.1 million and $48.1 million.

Potential mitigation for 82 affected communities has been estimated at between $4.3 million and $12.9 million. Community-level impacts could be addressed by providing block grants to affected communities in the region for economic diversification activities. For example, to mitigate farm communities most affected by the loss of river transportation, economic development programs could be used to create more local value-added products and decrease the dependency on the export of unprocessed grains to foreign markets.

Under Alternative 2, Maximum Transport, the lower probability and higher degree of risk associated with anadromous fish recovery may lead to negative economic and social impacts to sport-fishing-dependent communities. These communities may lose an important component of their economic base and may need assistance to transition to another non-fishery-dependent job base.

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15. Glossary

Adverse Water Conditions: Water conditions limiting the production of hydroelectric power, either because of low water supply or reduced gross head or both. Also sometimes called critical water conditions.

Automatic Generation Control (AGC): Small, but frequent changes in generation necessary to regulate and transmit energy at 60 cycles per second.

Average Megawatt (aMW): The amount of megawatts averaged over a specified time period.

Average Water Conditions: Precipitation and runoff conditions which provide water for hydroelectric power development approximating the average amount and distribution available over a long time period, usually the period of record.

Avoided Costs: Costs required under the base condition (Alternative 1 – Existing Conditions) that would not be required under Alternatives 2 through 4.

Base Condition: The assumed future conditions from which all alternatives are compared against.

BEA: U.S. Department of Commerce, Bureau of Economic Affairs

Benefit-Transfer: Economic technique used to transfer existing studies, value estimates, and willingness to pay functions, to new policy contexts, sites, and affected populations.

BiOp: Biological Opinion.

BPA: Bonneville Power Administration.

BTU: British Thermal Unit.

Business Sales: Estimated gross receipts received by a business with the exception of those businesses in the trade sector where it is the margin or the value added by that business.

Capability: The maximum load which a generator, turbine, transmission circuit, apparatus, station, or system can supply under specified conditions for a given time interval, without exceeding approved limits of temperature and stress.

Capacity: The load for which a generator, turbine, transformer, transmission circuit, apparatus, station or system is rated. Capacity is also used synonymously with capability. For definitions pertinent to the capacity of a reservoir to store water, see Reservoir Storage Capacity.

> **Dependable Capacity:** The load-carrying ability of a station or system under adverse conditions for the time interval and period specified when related to the characteristics of the load to be supplied. The dependable capacity of a system includes net firm power purchases.
>
> **Hydraulic Capacity:** The maximum flow which a hydroelectric plant can utilize for energy.

Installed Capacity: The sum of the capacities in a powerplant or power system, as shown by the nameplate ratings of similar kinds of apparatus, such as generating units, turbines, or other equipment.

Overload Capacity: The maximum load that a generating unit or other device can carry for a specified period of time under specified conditions when operating beyond its normal rating but within the limits of the manufacturer's guarantee, or, in the case of expiration of the guarantee, within safe limits as determined by the owner.

Peaking Capacity: The maximum peak load that can be supplied by a generating unit, powerplant, or power system in a stated time period. It may be the maximum instantaneous load or the maximum average load over a designated interval of time. Sometimes called peaking capability.

Sustained Peaking Capacity: Capacity that is supported by a sufficient amount of energy to permit it to be fully usable in meeting system loads.

Capacity Value: That portion of the at-site or at-market value of electric power which is assigned to capacity.

Combined Cycle Plant (CC): An electric power plant consisting of a series of combustion turbines with heat extractors on their exhausts.

Combustion Turbine Plant (CT): An electric power plant consisting of natural gas or distillate oil-fired jet engines connected to a generator.

Consumer Surplus: Economic value received above the price actually paid.

Cost Effectiveness Analysis: Identification of the least cost method for providing various levels of output.

Critical Period: The multiple-month period when the limitation of hydroelectric power supply due to the shortage of available water is most critical with respect to system load requirements, as determined from an analysis of the historical streamflow record. The reservoir begins the critical period full; the available storage is fully drafted at one point during the period; and the critical period ends when the storage has completely refilled.

Demand: The rate at which electric energy is delivered to or by a system, part of a system, or piece of equipment, usually expressed in kilowatts or megawatts, for a particular instant or averaged over a designated period of time.

Demand Curve: Identifies quantities of a good or service that will be consumed at different prices.

Drawdown: The distance that the water surface elevation of a storage reservoir is lowered from a given or starting elevation as a result of the withdrawal of water to meet some project purpose (i.e., power generation, creating flood control space, irrigation demand, etc.).

Drawdown Regional Economic Workgroup (DREW): The interagency group developed to estimate the economic and social effects associated with alternatives being studied in the Lower Snake Juvenile Mitigation Feasibility Study.

Duration Curve: A curve of quantities plotted in descending sequential order of magnitude against time intervals for a specified period. The coordinates may be absolute quantities or percentages.

EIA: Energy Information Agency.

EIS: Environmental Impact Statement.

Energy: That which does or is capable of doing work. It is measured in terms of the work it is capable of doing; electric energy is usually measured in kilowatt-hours.

> **Average Annual Energy:** The average amount of energy generated by a hydroelectric project or system over the period of record.
>
> **Firm Energy:** Electric energy which is intended to have assured availability to the customer to meet any or all agreed upon portion of his load requirements.
>
> **Nonfirm Energy:** Electric energy having limited or no assured availability.
>
> **Off-peak Energy:** Electric energy supplied during periods of relatively low system demands.
>
> **On-peak Energy:** Electric energy supplied during periods of relatively high system demands.
>
> **Pumping Energy:** The energy required to pump water from the lower reservoir to the upper reservoir of a pumped-storage project.
>
> **Secondary Energy:** All hydroelectric energy other than primary energy. Secondary energy is generally marketed as non-firm energy.

Environmental Quality (EQ) Account: An accounting stance established by the 1983 U.S. Water Resources Council guidelines. This account is used to display and integrate qualitative information on the effects of the proposed alternatives on significant resources and attributes of the human environment.

Exports: Electric power which is transferred from a given power system to another (usually adjacent) power system. Export power must be included in the given power system's loads.

FERC: Federal Energy Regulatory Commission.

Forebay: The impoundment immediately above a dam or hydroelectric plant intake structure. The term is applicable to all types of hydroelectric developments (i.e., storage, run-of-river and pumped-storage).

Fossil-Fuel Plant: An electric power plant utilizing fossil fuels (coal, lignite, oil, or natural gas) as its source of energy.

Generation: The act or process of producing electric energy from other forms of energy; also, the amount of electric energy so produced.

Generating Unit: A single power-producing unit, comprised of a turbine, generator, and related equipment.

Generator: The electrical equipment in power systems that converts mechanical energy to electrical energy.

Gigawatt: One million kilowatts.

Heat Rate: A measure of generating station thermal efficiency, generally expressed as BTUs per net kilowatt-hour. It is computed by dividing the total BTU content of the fuel burned (or of heat released from a nuclear reactor) by the resulting net kilowatt-hours generated.

IMPLAN (IMpact analysis for PLANning): Input-Output model used to estimate effects of changes in direct benefits and costs on regional economies.

Imports: Electric power which is transferred into a power system from another (usually adjacent) power system. Import power is usually considered to be a generating resource.

Inflow: The rate of water flow into a reservoir or forebay during a specified period.

Input-Output Modeling: A regional economic analysis technique that models the sales flows among industries and government agencies based on historical purchase patterns for each industry and for consumers. This techniques is used to estimate the effects of changes in direct benefits and costs on regional economies.

Intertie: An electrical connection between two utility systems permitting the flow of power in either direction at different times between the two systems.

Kilowatt (kW): The electric unit of power, which equals 1,000 watts or 1.341 horsepower.

Kilowatt-Hour (kWh): The basic unit of electric energy. It equals one kilowatt of power applied for one hour of time.

LPMS: Lock Performance Monitoring System

Load: The amount of electric power delivered at a given point.

> **Intermediate Load:** That portion of the load between the base load and the peaking portion of the load.
>
> **Interruptible Load:** Electric power load which may be curtailed at the supplier's discretion, or in accordance with a contractual agreement.
>
> **Peak Load:** The maximum load in a stated period of time. The peaking portion of the load is that portion of the load that occurs for less than eight hours per day.

Head Loss: Reduction in generating head due to friction in the water passage to the turbine: includes trashrack, intake, and penstock friction losses.

Hydropower Impact Team (HIT): The study team consisting of up to 20 members from Federal and State agencies, Tribes, Northwest Power Planning Council, and several environmental and industry interest groups.

Hydrosim (or HYDSIM): Hydro Simulator Program. A hydro-regulation model used by BPA.

HYSSR: Hydro System Seasonal Regulation Program. A hydro-regulation model used by the Corps of Engineers.

Line Loss: Energy loss and power loss on a transmission or distribution line.

M&I: Municipal and Industrial water users.

Mechanical Availability: The ratio of the number of days in total period minus days out of service due to maintenance and forced outages, to the number of days in the total period.

Megawatt (MW): 1,000 kilowatts.

National Economic Development (NED) Account: The economic account that displays changes in the economic value of the national output of goods and services. The general measurement standard for the value of goods and services is defined as the willingness of users to pay for each increment of output associated with a proposed alternative.

NMFS: National Marine Fisheries Service

NPV: Net Present Value. The adjustment of a stream of investments to a common point in time.

NPPC: Northwest Power Planning Council.

NRSA: Nominal Range Sensitivity Analysis

Nuclear Power Plant: An electric generating station utilizing the energy from a nuclear reactor as the source of power.

O&M: Operation and maintenance.

O&M, R, R: Operation and maintenance, rehabilitation and repair.

Other Social Effects (OSE) Account: An accounting stance established by the 1983 U.S. Water Resources Council guidelines. This account addresses potential effects from perspectives that are relevant to the evaluation process but are not reflected in the NED, RED, or OSE accounts. Categories typically addressed as part of this account include community impacts; life, health, and safety factors; displacement; and long-term productivity.

Outage: The period during which a generating unit, transmission line, or other facility is out of service.

> **Forced Outage:** The shutting down of a generating unit, transmission line, or other facility for emergency reasons.
>
> **Maintenance Outage:** The removal of a generating unit for required maintenance at any time between scheduled outages.
>
> **Scheduled (Planned) Outage:** The shutdown of a generating unit, transmission line, or other facility for inspection or maintenance in accordance with an advance schedule.

Passive Use Value: The value that individuals place on the mere existence of something. Passive use values are the benefit received from simply knowing that the resource exists even if no use is made of it. Also known as existence value.

Period of Record: The historical period for which streamflow records exist.

Personal Income: The income received by all individuals in the economy from all sources. Made up of wages and salaries, proprietors income, rental income, dividends, personal interest income, and the difference between transfer payments (payouts) and personal contributions for social insurance.

Plant Factor: The ratio of the average load on the plant for the period of time considered to the aggregate rating of all the generating equipment installed in the plant.

PNW: Pacific Northwest.

Pondage: Reservoir storage capacity of limited magnitude, that provides only daily or weekly regulation of streamflow.

Power: The time rate of transferring energy. Electrical power is measured in kilowatts. The term is also used in the electric power industry to mean inclusively both capacity (power) and energy.

> **Continuous Power:** Hydroelectric power available from a plant on a continuous basis under the most adverse hydraulic conditions contemplated. Same as prime power.
>
> **Firm Power:** Power intended to have assured availability to the customer to meet all or any agreed upon portion of his load requirements.
>
> **Interruptible Power:** Power made available under agreements which permit curtailment or cessation of delivery by the supplier.
>
> **Nonfirm Power:** Power which does not have assured availability to the customer to meet his load requirements.
>
> **Prime Power:** Same as continuous power.
>
> **Seasonal Power:** Power generated or made available to customers only during certain seasons of the year.

Power Benefits: The monetary benefits associated with the output of a hydroelectric plant.

Power Plant (POWERPLANT): A generating station where prime movers (such as turbines), electric generators, and auxiliary equipment for producing electric energy are located.

PSW: Pacific Southwest.

Pumped-Storage Hydroelectric Plant: A hydroelectric power plant that generates electric energy for peak load use by utilizing water pumped into a storage reservoir, usually during off-peak periods: The two major types of pumped-storage hydroelectric plants are pump-back and off-stream pumped-storage plants.

Pump-Turbine (Reversible Turbine): A hydraulic turbine, normally installed in a pumped-storage plant, which can be used alternately as a pump and prime mover (turbine).

Ramp Rate: The maximum allowable rate of change in output from a powerplant. The ramp rate is established to prevent undesirable effects due to rapid changes in loading or (in the case of hydroelectric plants) discharge.

Regional Economic Development (RED) Account: The economic account that addresses change in the distribution of regional economic activity. Effects are addressed in terms of changes to regional business sales, employment, and income.

Reserve: The additional capacity of a power system that is used to cover contingencies, including maintenance, forced outages, and abnormal loads.

> **Cold Reserve:** Thermal generating capacity available for service but not maintained at operating temperature.
>
> **Hot Reserve:** Thermal generating capacity maintained at a temperature and condition which will permit it to be placed into service promptly.
>
> **Spinning Reserve:** Generating capacity connected to the bus and ready to take load. It also includes capacity available in generating units which are operating at less than their capability.
>
> **Standby Reserve:** Reserve capacity which can be placed on-line in a matter of minutes. Includes hot reserve capacity, combustion turbines, and most idle hydroelectric capacity.
>
> **System Required Reserve:** The system reserve capacity needed as standby to insure an adequate standard of service.

Rule Curve: A curve or family of curves indicating how a reservoir is to be operated under specific conditions to obtain best or predetermined results. Rule curves can be designated to regulate storage for flood control, hydropower production, and other operating objectives, as well as combinations of objectives.

Runner: The rotating part of a turbine.

Run-of-River Plant: A hydroelectric power plant utilizing pondage or the flow of the stream as it occurs.

SBC: Surface Bypass Collector. A type of fish bypass facility.

SOR: Columbia River System Operation Review

Spill: The discharge of water through gates, spillways, or conduits which bypasses the turbines of a hydroelectric plant.

Station Use: Energy power used in a generating plant as necessary in the production of electricity. It includes energy consumed for plant light, power, and auxiliaries regardless of whether such energy is produced at the plant or comes from another source.

Storage Plant: A hydroelectric plant associated with a reservoir having power storage.

Storage Project: A project with a reservoir of sufficient size to permit carryover from the high-flow season to the low-flow season, and thus to develop a firm flow substantially more than the minimum natural flow. A storage project may have its own powerplant or may be used only for increasing generation at some downstream plant.

Streamflow: The rate at which water passes a given point in a stream, usually expressed in cubic feet per second (cfs).

Natural Streamflow: Streamflow at a given point of an uncontrolled stream, or regulated streamflow which has been adjusted to eliminate the effects of reservoir storage or upstream diversions.

Regulated Streamflow: The controlled rate of flow at a given point during a specified period resulting from reservoir operation.

Supply Curve: Identifies quantities of a good or service that firms will produce at different prices.

Tailrace: The channel or canal that carries water away from a dam. Also sometimes called afterbay.

Tailwater Elevation: The elevation of the water surface downstream from a dam or hydroelectric plant.

Thermal Plant: An electric power plant which derives its energy from a heat source, such as combustion, geothermal water or steam, or nuclear fission. Includes fossil-fuel and nuclear steam plants and combustion turbine and combined cycle plants.

Transmission: The transporting or conveying of electric energy in bulk to a convenient point at which it is subdivided for delivery to the distribution system. Also used as a generic term to indicate the conveying of electric energy over any or all of the paths from source to point of use.

Travel Cost Method (TCM): A technique that uses the actual number of trips taken by an individual as the quantity variable and the visitor's travel cost as the price variable to identify a demand curve for recreation.

TVA: Tennessee Valley Authority.

Watt: The basic electrical unit of power or rate of doing work. The rate of energy transfer equivalent to one ampere flowing under a pressure of one volt at unity power factor. One horsepower is equivalent to approximately 746 watts.

WCSC: Waterborne Commerce Statistics Center

Wheeling: The transfer of power and energy from one utility over the transmission system of a second utility for delivery to a third utility, or to a load of the first utility.

Western System Coordinating Council (WSCC): One of nine regional energy reliability councils that were formed due to a national concern regarding the reliability of interconnected bulk power systems. The WSCC comprises all or part of the 14 Western States and British Columbia, Canada.

Willingness to Pay (WTP): The expressed amount an individual would pay for something. For goods sold in a market, the WTP is the amount actually paid to obtain the good plus an additional amount that an individual would have been willing to pay for the chosen quantity of the good. For non-market goods, WTP is the expressed amount an individual would pay.

WRC (U.S. Water Resources Council) (1983) Guidelines: The Economic and Environmental Principles and Guidelines for Water and related Land Resources Implementation Studies developed by the U.S. Water Resources Council (1983). The analysis presented in this appendix is based on these guidelines.